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CATALOG OF THE FOSSIL FISHES IN THE CARNEGIE MUSEUM. PART III. CATALOG OF FOSSIL FISHES FROM THE LITHOGRAPHIC STONE OF CERIN, FRANCE.

By C. R. Eastman.

(Plates XLVIII–LVI.)

The subject matter of the following Catalog consists of a large and representative assortment of Upper Jurassic fishes from Cerin (Ain) in southeastern France, the material being contained in the Bayet Collection, which was acquired by the Museum through the generosity of Mr. Andrew Carnegie in 1903.

It is now generally considered that the deposits of lithographic limestone in the Department of Ain, France, and in the vicinity of Solenhofen, Bavaria, are of contemporary age, both being referable to the Lower Kimmeridgian division of the marine Upper Jura, and not to the Corallian (upper member of the Middle Jura), as some writers have supposed. The stratigraphic relations of the fish-bearing beds at Cerin will be clear from an inspection of the annexed diagram showing the geological section across this region.

Essentially the same ichthyic fauna is represented in the lithographic stone of Cerin, France, and in similar deposits of the general region around Solenhofen, Bavaria; the latter locality, however, furnishing the more abundant and more diversified forms of animal life. The composition of the fish-fauna is essentially " ganoid "; that is to say, teleost fishes of the Crossopterygian and Actinopterygian orders predominate, cartilaginous forms are in the minority, and the Dipnoan sub-class is without known representatives. Among Elasmobranch fishes the Batoidei, or rays, outnumber the sharks, and Holocephali occur very sparsely

at the Bavarian locality, no trace of them having been found in the corresponding deposits in France. In many cases where the same genera occur in both localities, they are found to be represented by different species, as is perhaps natural to expect from the point of view of geographic distribution.

Besides the fishes, some fifty species of which were known from Cerin during the life-times of Louis Agassiz and Victor Thiollière, mention should be made of

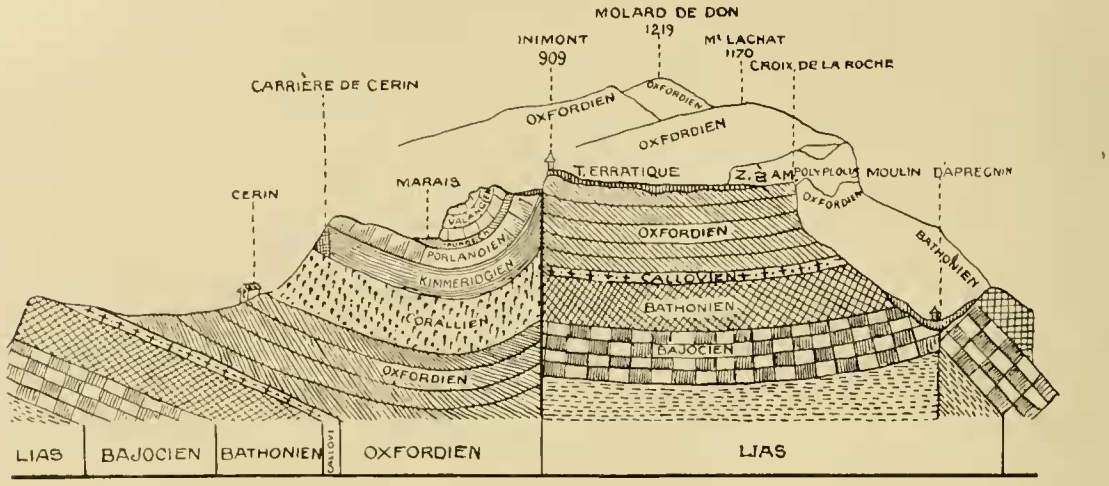


Fig. 1. Geological Section in the Vicinity of Cerin, France. (After Gervais).

the occurrence of Rhynchocephalian and Pterosaurian genera in the French deposits, also of a considerable number of insects and crustacea, apparently identical with those which are found in Bavaria.

Of somewhat different nature lithologically, but yielding approximately the same ichthyic fauna, and regarded in consequence as the homotaxial equivalent of the beds at Cerin, is the Lower Kimmeridgian bituminous limestone of Orbagnoux, Ain, France. One of the pioneer students of this fauna, Victor Thiollière of Lyons, writing in 1854, speaks as follows regarding the synchronism of the deposits at Orbagnoux, Cerin, and Solenhofen:

" Les schistes d'Orbagnoux sont principalement représentés dans la collection de M. Itier par leurs végétaux nombreux et variés; mais ils avaient aussi fourni . . . toute une serie de *Thrissops, Leptolepis, Aspidorhynchus, Caturus, Pycnodus* [=*Microdon*? Eastman] et autres poissons, que j'ai examinés avec d'autant plus d'intérêt qu'ils m'ont donné la pleine conviction de l'identité de la faune ichthyologique des schistes bitumineux avec celle des calcaires lithographiques. Cette identité, que je n'avais annoncée en 1850 que sur des preuves moins décisives, ne peut pas plus être revoquée en doute aujourd'hui, que celles de tout l'ensemble qui

en resulte avec la faune de Solenhofen." "Les Poissons Foss. &c., dans le Bugey," p. 3.

The medium in which organic remains are preserved in the calcareous and bituminous deposits of southeastern France has not the same fineness as that of the Bavarian lithographic stone, hence the more delicate details are less exquisitely portrayed in the form of impressions than at the famous locality of Solenhofen. Nevertheless the perfection in which most of the hard parts are preserved in the rock is truly marvellous. The chief difficulty with which vertebrate paleontologists have to contend is the accidental distortion or displacement of parts owing to pressure of freshly deposited sediment during fossilization.

A brief résumé may be offered at this point concerning earlier contributions to our knowledge of the Jurassic fish-fauna of the Bugey. Local geologists appear to have become interested in collecting fossil remains from this region as early as the second decade of the nineteenth century, and credit for having discovered the fish-bearing beds of Cerin is awarded by later writers to M. Jules Itier, who began in 1821 the preparation of a geological map of the Department of Ain. The conclusions reached by this excellent observer after many years of patient effort were finally published in a communication entitled " Memoirs sur les roches asphaltiques de la chaîne du Jura."[1]

In 1838 a civil engineer and geologist, named M. Drian, brought together a small collection of fish-remains from the quarries of lithographic stone of Cerin in the commune of Marchamp (Ain), and some eight years later these remains passed into the hands of M. Victor Thiollière of the University at Grenoble, who at once became deeply interested in their investigation, and whose labors were unfortunately cut short by death before his final memoir was completed. It is affirmed by Professor Thiollière's associates, MM. Falsan and Dumortier, that the beginning of our knowledge of the Cerin fish-fauna is traceable to the lively curiosity aroused by the collection of the Lyonese geologist, Drian. The latter, in 1838 as stated by these authors, " découvrit les belles empreintes de poissons de la carrière de Cerin, commune de Marchamp (Ain); puis en 1846 il les communiqua à V. Thiollière. L'examen de ces échantillons fut le point de départ des persévérantes et remarquables recherches de ce dernier savant, qui, pour s'occuper uniquement de l'étude de cette riche faune et pour combler une lacune restée dans les travaux géologiques français n' hésita pas à abandonner le tracé de la carte géologique du département du Rhone."

Two short notices were published by M. Thiollière during the years 1848–50, the second of which contained a description of certain reptilian remains from the

[1] Bull. de la Soc. de Statistique de l'Isère, Vol. II, 1839, p. 128.

same region, which had been submitted to Hermann von Meyer and studied by him.[2] In 1854 appeared the handsome memoir of Thiollière, upon which his claims for recognition as a student of paleichthyology chiefly rest.[3] The sequel to this work was not completed during the author's life-time, although a dozen plates intended for its illustration had been printed in 1858, and were exhibited before the visiting members of the French Geological Society at a meeting held at Nevers in that year. A short paper presented by Thiollière on this occasion was his last published contribution,[4] death having ensued a few months later; but in 1873 the aforementioned plates were issued under the editorial care of M. Paul Gervais, accompanied by annotated extracts from some of Thiollière's earlier writings, and by essays on the local paleobotany and a stratigraphic section at the hands of Count de Saporta and MM. Falsan and Dumortier. This publication, designated as "seconde livraison," appears under the same title as Thiollière's memoir of 1854, and is evidently intended to be supplementary to it.

At the beginning of his introductory remarks prefixed to the memoir of 1873 just referred to, Professor Gervais makes the following significant observation: "Une étude plus complète de la collection Thiollière, aujourd'hui déposée au Muséum de Lyon, et une nouvelle comparaison des poissons qu'elle comprend avec ceux qu' on a recueillis dans les terrains analogues de la Bavière et ailleurs, conduiront à des résultats plus importants encore. Nous ne saurions trop recommander ces recherches aux naturalistes qui seront en mesure de les accomplir."

We have quoted the foregoing remarks in order to show that it was realized by competent paleontologists two score years ago that a thorough-going revision and comparative study of the Solenhofen and Cerin vertebrate faunas was a desideratum, and that such an investigation promised extremely valuable results. Thiollière and Andreas Wagner of Munich had previously held the same opinion, as will appear from the following comments of the first-named author, with reference to the collections from Solenhofen: "On sait que les richesses dont il s'agit n'ont pas été suffisamment étudieés par M. Agassiz. Il est urgent, comme le remarque

[2] Première notice sur un nouveau gisement de poissons fossiles dans le Jura du Département de l'Ain. Annales de la Soc. Nationale d'Agriculture, Histoire Naturelle, et Arts Utiles de Lyon, Vol. I, 1849, pp. 43–66.

Seconde notice sur le gisement et sur les corps organisés fossiles des calcaires lithographiques dans le Jura du Département de l'Ain, comprenant la description de deux reptiles inédits provenant de ces couches, par M. Hermann de Meyer. Lyons, 1850, p. 80, with 2 plates.

[3] "Description des Poissons Fossiles Provenant des Gisements Coralliens du Jura dans le Bugey." Lyons, 1854, pp. 28, with 10 plates.

[4] "Notice sur les Poissons Fossiles du Bugey et sur l'Application de la Méthode de Cuvier à leur Classement." Bull. Soc. Géol. de France, Vol. XV, p. 782.

fort justement M. Wagner, de faire disparaître les lacunes, les doutes, et les inexactitudes que le célèbre naturaliste de Neufchâtel a été forcé de laisser dans ses *Recherches*, relativement aux espèces des schistes lithographiques de la Bavière."[5]

Fortunately for the science of paleichthyology the lacunæ in our knowledge of the Kimmeridgian fish-fauna of Bavaria, of which writers of half a century ago complained, have been in large measure filled by the unremitting researches of a long procession of students. Deficiencies still exist, however, in the extent and thoroughness of our knowledge of the contemporary ichthyic fauna of southeastern France. The quarries of lithographic stone in this region are relatively little worked and in some localities have been abandoned; the supply of materials is at best scanty; and the region is less easily accessible than the level plateau country of the Alb in northern Bavaria.

For these and various other reasons comparatively few investigators have been in later years attracted to the study of the Cerin fauna. The list is, indeed, exhausted when we have mentioned the names of A. Wagner and Karl A. von Zittel of Munich, and Professor Albert Gaudry of Paris, all deceased, and H. E. Sauvage of Boulogne-sur-Mer, and Dr. A. Smith Woodward of London. Through exchange with the Lyons Museum of Natural History in 1873, a number of well-preserved specimens from Cerin were received by the Museum of Comparative Zoölogy at Cambridge, Massachusetts. This material has been studied in connection with that belonging to the Carnegie Institute in Pittsburgh, and a portion of the results is incorporated in the present modest contribution.

After the above general statements we proceed to the description of the different genera and species from Cerin represented in the collection of the Carnegie Museum. As in the preceding parts of the Catalog, the systematic arrangement of families and genera follows closely that laid down in Dr. A. Smith Woodward's "Catalogue of Fossil Fishes," and the chief diagnostic characters have been almost entirely extracted from the same source.

CLASS PISCES.

Subclass I. ELASMOBRANCHII.

Order PLAGIOSTOMI.

"Head prolonged in front of the ventrally-situated mouth as a more or less prominent pre-oral rostrum; vertebral column consisting of alternating basi- and inter-dorsal cartilages, generally supported by more or less well developed chorda-centra. Pectoral and pelvic fins uniserial. Pelvic girdle and claspers

[5] Memoir of 1854, p. 6.

present. Except in two families the branchial arches and clefts are invariably five in number. An operculum is not developed." (T. W. Bridge, Cambridge Natural History, Fishes, p. 442).

Suborder *BATOIDEI.*

"Body generally discoidal or rhombic in shape, the axial portion being formed by the flattened head and trunk, and the lateral portions by the enormously expanded pectoral fins, which are usually confluent with the sides of the head. Tail slender, sharply marked off from the trunk, to which it usually appears as a mere appendage. Dorsal fins, when present, on the tail. Anal fin absent. Branchial clefts ventral in position. Spiracles large, usually crescentic. Vertebræ tectospondylic." (T. W. Bridge, *l. c.*, pp. 457–8).

Family RHINOBATIDÆ.

"Tail strong and long, with two well-developed dorsal fins; a caudal and a longitudinal fold on each side. Disk not excessively dilated, the rayed portion of the pectoral fins not being continued to the snout. No electric organs in the living forms." (A. S. Woodward, Cat. Fishes B. M., Pt. I, p. 77). Teeth small, numerous, in pavement.

Genus Belemnobatis Thiollière.

"Tail very distinct from the disk, which is almost of rhombic shape. Pectoral fins not extending forwards beyond the base of the snout; pelvics not notched. Tail with two smooth spines upon the proximal half, and *apparently* two dorsal fins on the distal half, without caudal fin. Body partially covered with conical dermal tubercles, the larger only superficially calcified. Teeth minute, smooth." (A. S. Woodward, *l. c.*, p. 83).

1. **Belemnobatis sismondæ** Thiollière.

1854. *Belemnobatis sismondæ* Thiollière.

Poiss. Foss. Bugey, Pt. I, p. 8; pl. III, fig. 1.

1873. *Belemnobatis sismondæ* Thiollière.

Op. cit., Pt. II (*ed.* P. Gervais), p. 12; pl. I, fig. 1.

1889. *Belemnobatis sismondæ* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. I, p. 84.

Type.—Complete skeleton; present location unknown.

"Snout moderately obtuse; tail shorter than disk. Dermal tubercles largest between the pelvic fins; of considerable size along the median line of the back and on the anterior portion of the disk." (A. S. Woodward, *l. c.*, p. 84). Total length upwards of 50 cm.

This rare form, of which but few specimens have been brought to light, is represented in the collections of the Carnegie Museum from Cerin, by a single imperfect individual, which displays the greater part of the disk and a few caudal vertebræ. Both the pectoral and pelvic arches together with the branchial clefts and cartilaginous rays (radialia) of both pairs of fins are well exhibited. The specimen is cataloged as No. 5131.

Subclass TELEOSTOMI.

Order CROSSOPTERYGIA.

Suborder *ACTINISTIA*.

Family CŒLACANTHIDÆ.

"Body deeply and irregularly fusiform, with cycloidal, deeply overlapping scales, more or less ornamented with ganoine. Branchiostegal apparatus consisting of an operculum on each side and a single pair of large jugular plates. Paired fins obtusely lobate. Two dorsal fins and a single anal; the anterior dorsal without baseosts, obtusely lobate. Axial skeleton extending to the extremity of the caudal fin, usually projecting and terminated by a small supplementary caudal fin. Air-bladder ossified." (A. S. Woodward, *l. c.*, Pt. II, p. 394).

This family, first recognized by Professor Agassiz in the second volume of his Poissons Fossiles (1844, p. 168), and afterwards greatly restricted by Huxley in two important memoirs of the British Geological Survey (Decades X and XII, 1861 and 1866), is at present understood as comprising not more than six clearly defined genera, among which the most satisfactorily known are *Cœlacanthus* proper, *Macropoma*, and *Undina*. The typical genus enjoys a truly remarkable range from the Upper Devonian to the close of the Paleozoic, and if the evidence of one or two doubtful forms be deemed trustworthy, possibly even higher in the stratigraphic column. The remaining genera extend throughout the Mesozoic, and exhibit such constancy of structural characters that the group has been cited as one of the most distinct and sharply demarcated in the animal kingdom. Huxley, for instance, remarks upon its singular compactness and homogeneity in the following paragraph:

" The Cœlacanthini, as thus understood, are no less distinctly separated from other fishes than they are closely united to one another. In the form and arrangement of their fins, the structure of the tail and that of the cranium; the form and number of the jugular plates; the dentition; the dorsal interspinous bones; the pelvic bones, the ossified air-bladder; the Cœlacanthini differ widely from either the Saurodipterini, the Glyptodipterini, or the Ctenodipterini; but, on the other

hand, they agree with these families and differ from almost all other fishes, in the same respects as those in which the families just mentioned have been shown to agree with one another; viz., the number of the dorsal fins, the location of the paired fins, the absence of branchiostegal rays and their replacement by jugular bones."[6]

In a subsequent memoir the author whom we have just quoted speaks as follows regaring the extraordinary conservatism and persistence manifested by the group of Cœlacanth fishes ever since its introduction:[7]

"Bearing in mind the range of the Cœlacanths from the Carboniferous [since ascertained to extend from the Devonian] to the Chalk formations inclusive, the uniformity of organization of the group appears to be something wonderful. I have no evidence as to the structure of the base and side-walls of the skull in Cœlacanthus, but the data collected in the present Decade shows that, in every other particular, save the ornamentation of the fin-rays and scales, the organization of the Cœlacanths has remained stationary from their first recorded appearance to their exit. They are remarkable examples of what I have elsewhere termed 'persistent types,' and, like the Labyrinthodonts, assist in bridging over the gap between the Paleozoic and the Mesozoic faunæ."

The chief feature in which this family shows specialization is in the large symmetrical caudal fin, which exhibits a series of supports directly apposed to the neural and hæmal arches, equalling in number both these and the overlapping dermal rays. It is also specialized, as noted by Dr. A. S. Woodward,[8] in the following respects: (i) the fusion of the bones of the pterygoquadrate arcade; (ii) the reduction of the infradentaries to one; (iii) the reduction of the opercular apparatus to one operculum on each side and a pair of gular plates; (iv) the loss of the baseosts in the anterior dorsal fin; and (v) the ossification of the air-bladder.

Genus Undina Münster.

"Teeth absent on the margin of the jaws, but a few hollow, conical teeth within. Supplementary caudal fin prominent; the rays of all the fins broad and robust, often expanded, and closely articulated in the distal portion; small, upwardly-pointing denticles on the preaxial rays of the first dorsal and caudal fins. External

[6] Huxley, T. H., Preliminary essay upon the systematic arrangement of the Fishes of the Devonian Epoch, prefixed to the tenth decade of Figures and Descriptions illustrating British Organic Remains (1861, p. 20).

[7] Huxley, T. H., Illustrations of the Structure of the Crossopterygian Ganoids. Memoirs of the Geological Survey of the United Kingdom, Decade XII., 1866, and reprinted in the supplementary volume of the Scientific Memoirs of Thomas Henry Huxley, 1903, p. 65.

[8] Outlines of Vertebrate Palæontology, 1895, p. 78.

bones and scales superficially ornamented with tubercles or fine interrupted ridges of ganoine; parafrontal and circumorbital bones plate-like, without superficial excavations." (A. S. Woodward, *l. c.*, Pt. II, p. 409).

2. **Undina penicillata** Münster.

1834. *Undina penicillata* G. von Münster.
Neues Jahrb., p. 539.
1842. *Cœlacanthus striolaris* G. von Münster.
Neues Jahrb., p. 40.
1842. *Cœlacanthus kohleri* G. von Münster.
Ibid., p. 40.
1842 *Cœlacanthus striolaris* G. von Münster.
Beitr. Petrefakt., Pt. V, p. 57; pl. II, figs. 1, 3, 5, 6, 8, 9, 10, 12, 14, 16.
1844. *Undina striolatus* and *U. kohleri* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, p. 171.
1863. *Undina penicillata* A. Wagner.
Abh. Math.-Phys. Cl., K. Bayer. Akad. Wiss., Vol. IX, p. 696.
1869. *Cœlacanthus penicillatus* R. von Willemoes-Suhm.
Palæontographica, Vol. XVII, p. 80; pl. X, figs. 2, 3; pl. XI, fig. 3.
1871. *Cœlacanthus harlemensis* T. C. Winkler.
Archives Mus. Teyler, Vol. III, p. 101; pl. IV.
1881. *Cœlacanthus harlemensis* B. Vetter.
Mittheil. K. Mineral.-Geol. Mus. Dresden, Pt. IV, p. 13; pl. II, fig. 4.
1887. *Undina penicillata* K. A. von Zittel.
Handb. Paläont., Vol. III, p. 175, fig. 177.
1887. *Undina acutidens* K. A. von Zittel.
Ibid., p. 175, fig. 177*b* (fig. of scales only).
1888. *Undina penicillata* O. M. Reis.
Palæontogr., Vol. XXXV, pp. 30, 36; pl. II, figs. 5, 6, 9, 10; pl. IV, figs. 3, 4.
1888. *Undina acutidens* O. M. Reis.
Ibid., pp. 10, 36; pl. I, figs. 2–6, 8–24.
1891. *Undina penicillata* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. II, p. 410.

Type.—Nearly complete fish; Paleontological Museum, Munich.

"This species, which is the type of the genus, attains a length of about 40 cm. Trunk robust, but elongated; head and opercular apparatus occupying somewhat less than one-quarter of the total length. Fin-rays slightly expanded in the ar-

ticulated distal half; dorsal fins well developed, the first consisting of about ten relatively stout rays, the second and the anal each comprising at least twice that number of more slender rays; principal caudal fin comprising about eighteen to twenty stout rays above and below. Jugular plates four times as long as broad, covered with sparse elongated tubercles; operculum, cheek-plates, and mandible delicately tuberculated. Scales ornamented with numerous irregularly and closely arranged elongated tubercles." (A. S. Woodward, *l. c.*, Pt. II, p. 410).

The above synonymy and diagnosis are taken from A. Smith Woodward, who regards it as still doubtful whether the Cœlacanth remains described by Thiollière from the Upper Jura of Cerin, under the name of *Undina cirinensis* (Poiss. Foss. Bugey, pt. i, 1854, p. 10) are not identical with the type-species.

The status of the specific names hitherto applied to Cerin forms, namely *U. cirinensis* and *U. minuta*, will be readily understood from the following observations by Willemoes-Suhm (Palæontographica, 1869, Vol. XVII, p. 79):

"Thiollière beschreibt aus Cirin einen kleinen Cœlacanthus [= *Undina*] der sich von Münsters *penicillatus* nur dadurch unterscheidet, dass, während dieser oben 21 und unten 17–18 Strahlen in der Caudale zeigt, oben nur 15 und unten 13 vorhanden sind. Wagner fand nun unter den ebenfalls aus Cirin dem Münchener Museum eingesandten Fossilien einen sehr kleinen Cœlacanthen, der im Ganzen gut erhalten ist, doch den hintern Körpertheil von der zweiten Rückenflosse an verloren hat. Bei Aufstellung dieser Species legt er nun besonderes Gewicht auf die Kleinheit des gefundenen Exemplars die ihm als Charakter genügt. Ich kann mich dieser Ansicht nicht anschliessen. . . . Falls vollständigere kleinere Exemplare gefunden werden, wird sich vielmehr wahrscheinlich herausstellen, dass auch der *Coelacanthus minutus* zum Thiollières *Cœlacanthus cirinensis* gehört."

Thiollière's description of his so-called *Undina cirinensis* was published in 1854, and the small form named by Wagner *Undina minuta*, likewise from Cerin, was not described until 1863, hence Thiollière's name has priority, in case both are not synonyms of *U. penicillata*. The original of the French author's description is stated to have had a total length of 28 cm. and maximum depth of about 6 cm. Wagner's type was considerably smaller, and may well have been an immature individual. A much larger specimen of *Undina* than any hitherto made known, and one which presents differences apparently having specific value, is that described below.

3. **Undina grandis** sp. nov. (Plate XLVIII, fig. 2).

A large and imperfectly definable species, estimated to have equalled *U. gulo* in size, and differing from it and other described forms in the structure,

position, and ornamentation of the median fins. Anterior portion of the body unknown.

Type.—Posterior portion of large fish; Carnegie Museum, Cat. No. 4748.

It is unfortunate that the complete form of the body is unknown in the species under discussion, which is founded upon an imperfectly preserved and somewhat distorted caudal portion of a fish considerably exceeding *U. penicillata* in size, and approximating *U. gulo*. In so far as the number of rays supporting the lobes of the principal caudal fin may be relied upon as a differential character, the new species presents the following contrast to its congeners:

Name of Species.	Number of Caudal Fin-rays.
Undina gulo (Egerton)	16–18 above and below.
" *penicillata* Münster	18–20 " " "
" *cirinensis* Thiollière	15 " ; 13 "
" *grandis* Eastman	25 " ; 19 "

The supplementary caudal fin in the form under discussion is relatively shorter, that is, less produced backwards, than in other species, and comprises eleven flexed and articulated rays above and below. A noteworthy feature is that the rays of the principal caudal are provided along their expanded lateral surface with a series of minute conical denticles, similar to those occurring along the posterior border of the dorsal fin-rays of certain species of *Macrosemius*. The rays of all the fins are acutely pointed at their distal extremities. The posterior dorsal and anal fins comprise each about fifteen rays, are more acuminate than in other species, and arise nearer the base of the caudal fin. The position of the pelvic and pectoral pair is indicated in the type-specimen, and the pair of elongated and slender basipterygia, which are apparently fused, where they meet in an expanded distal process, are well displayed.

The axis is remarkably broad, tapers gradually posteriorly, but becomes expanded in the region of the articulated portion of the caudal fin-rays, after which it again tapers, being continued to the tip of the supplementary caudal fin. The lateral line is prominent, and runs parallel with the cartilaginous axis. None of the scales display the outer surface satisfactorily, but appearances suggest that the external ornament consisted of rather sparse and discontinuous ridges of ganoine, directed more or less longitudinally or slightly radiating. The covered portion of the scales is marked by numerous delicate concentric striæ crossed by another fine series having a fan-shaped arrangement. In *U. gulo* and *U. penicillata* the scales are externally ornamented with numerous closely spaced elongated tubercles; and in *U. cirinensis* the scale characters are thus described by the original author:

"Les écailles proprement dites sont à peu près indiscernables, bien qu'elles existent: ce qui tient à leur très-faible épaisseur; mais on reconnaît à la loupe, que la surface du corps est parsemée de petites épines fort aiguës, disposées par zones qui doivent correspondre au bord postérieur des écailles" (Thiollière, *l. c.*, p. 10).

Order **ACTINOPTERYGII.**

Suborder *PROTOSPONDYLI.*

Family SEMIONOTIDÆ.

"Trunk more or less deeply fusiform, rarely cycloidal. Cranial and facial bones all robust and opercular apparatus complete, but branchiostegals sometimes reduced; parietals meeting in the middle line; mandibular suspensorium vertical or inclined forwards, and gape of mouth small; teeth styliform or tritoral, especially well developed on the inner bones of the mouth, and with vertical successors. Notochord persistent, the vertebræ never advancing beyond the annular stage. Fin-rays robust, the majority well-spaced, articulated, and divided distally; fulcra large; dorsal fin not extending more than half the length of the trunk. Scales rhombic, except occasionally in the caudal region." (A. S. Woodward, *l. c.*, Pt. III, p. 49).

Genus Lepidotus Agassiz.

"Trunk fusiform and only moderately compressed. Marginal teeth robust, styliform, inner teeth stouter, often tritoral but smooth; opercular apparatus well-developed, with a narrow arched pre-operculum, but with few branchiostegal rays, and the gular plate wanting. Ribs ossified. Fin-fulcra very large, present on all the fins, biserial. Paired fins small; dorsal and anal fins short and deep, the former opposed to the space between the latter and the pelvic fins; caudal fin slightly forked. Scales very robust, smooth or feebly ornamented; flank-scales not much deeper than broad, with their wide overlapped margin produced forwards at the superior and inferior angles; scales of the ventral aspect nearly as deep as broad; dorsal and ventral ridge-scales usually inconspicuous." (A. S. Woodward, *l. c.*, Pt. III, p. 77).

4. **Lepidotus lævis** Agassiz. (Plate XLVIII, Fig. 1).

1837–44. *Lepidotus lævis* L. Agassiz.

Poiss. Foss., Vol. II, Pt. I, p. 254; pl. XXIX*c*, figs. 4–6.

(?) 1846. *Lepidotus subundatus* G. von Münster (*errore*).

Beitr. Petrefakt., Pt. VII, p. 37; pl. III, fig. 16.

1860. *Lepidotus lævis* F. J. Pictet.

Descript. Rept. et Poiss. Foss. Jura Neufchâtelois, p. 26, Pls. VI, VII.

1875. *Lepidotus lævis* K. Fricke.

Palæontogr., Vol. XXII, p. 377; pl. XXI, fig. 1.

1895. *Lepidotus lævis* A. S. Woodward.

Cat. Foss. Fishes B. M., Pt. III, p. 103.

1908. *Lepidotus lævis* F. Priem.

Annales de Paléont., Vol. III, p. 10; Pl. I, fig. 1.

Type.—Scale; Museum of Soleure, Switzerland.

A robust species, attaining a length of about 75 cm., the proportions in general resembling those of *L. elvensis*, but with deeper body, the maximum depth being contained only about two-and-a-half times in the total length. External bones more or less rugose and ornamented with prominent and closely spaced tuberculations. Teeth short, stout, and smooth, the majority oval in outline, and sometimes showing a median coronal tubercle or apex; splenial teeth apparently in more than three concentric series. Scales large and smooth, none much deeper than long, except those of the middle of the flank anteriorly; principal flank-scales with a few broad ridges and furrows radiating from the center to the hinder border, where they form a distinct pectination; as many as forty-three transverse scale-rows from the region of the pectoral arch to the base of the caudal fin.

Until recently, no well-preserved examples of this species have been known from the lithographic stone of Cerin. In 1908, however, a very excellent specimen belonging to the Paris Museum of Natural History was described by Professor F. Priem, and one nearly as large and quite as well preserved forms part of the Bayet Collection of the Carnegie Museum, cataloged as No. 5130. In it all of the fins, with the exception of the dorsal and caudal, are tolerably well shown, and the cranial osteology is unusually well displayed. It will be profitable to compare the figure that is given of the head with Professor Priem's diagram (*l. c.*) showing the relation of the cranial and facial elements in the specimen studied by him.

Family MACROSEMIIDÆ.

"Trunk elongate, or elongate-fusiform, more or less laterally compressed. Cranial and facial bones moderately robust, or delicate, and opercular apparatus complete; mandibular suspensorium vertical or inclined forwards, and gape of mouth small; marginal teeth styliform, inner teeth similar or tubercular. Notochord persistent, the vertebræ never advancing beyond the annular stage. Fin-rays robust, the majority well-spaced, articulated and divided distally; fulcra

variable; dorsal fin elongated, usually extending at least half of the length of the trunk. Scales rhombic." (A. S. Woodward, *l. c.*, Pt. III, p. 163).

Genus Ophiopsis Agassiz.

"Trunk much elongated, gradually tapering from the occiput backwards or the dorsal margin only slightly arcuate; head large or of moderate size. Marginal teeth acutely pointed. Notochord invested with delicate ring-vertebræ; ribs ossified. Bifurcation of dorsal fin-rays variable; fulcra often absent on paired fins and usually confined to the base of the median fins. Paired fins relatively large; dorsal fin ordinarily extending about half the length of the back, high in front, low behind; anal fin small; caudal fin forked. Scales covering the whole of the trunk, in regular series, united by peg-and-socket articulation, and often pectinated at the hinder border; the scales at the middle of the flank scarcely deeper than broad, few of the ventral scales much broader than deep; no enlarged ridge-scales." (A. S. Woodward, *l. c.*, Pt. III, p. 165–6).

5. **Ophiopsis attenuata** Wagner.

1863. *Ophiopsis attenuata* A. Wagner.

Abhandl. K. Bay. Akad. Wiss., Math.-Phys. Cl., Vol. IX, p. 655.

1873. *Ophiopsis attenuata* Thiollière.

Poiss. Foss. Bugey, Pt. II, p. 19; pl. VIII, fig. 2.

1895. *Ophiopsis attenuata* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 167; pl. III, figs. 2, 3.

Type.—Trunk of fish; Paleontological Museum, Munich.

A species attaining a length of about 15 cm. Length of head with opercular apparatus equalling the maximum depth of the trunk, and contained about five times in the total length of the fish; maximum depth of trunk twice as great as the width of the caudal pedicle. External head-bones and opercular bones smooth. Dorsal fin occupying about one-half of the length of the back, the length of the dorsal fin-rays rapidly decreasing in a posterior direction, and most of them undivided. Scales delicately serrated, not pectinated.

This species is represented in the Carnegie Museum by two average-sized and tolerably well-preserved individuals, cataloged under the numbers 4041 and 4422.

6. **Ophiopsis guigardi** Thiollière.

1873. *Ophiopsis guigardi* Thiollière.

Poiss. Foss. Bugey, Pt. II, pl. VII (figure only).

1895. *Ophiopsis guigardi* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 169.

"*Type*.—Nearly complete fish; Lyons Museum.

A species attaining a length of about 30 cm. Length of head with opercular apparatus equal to the maximum depth of the trunk and contained about five-and-a-half times in the total length of the fish; maximum depth of trunk twice as great as the depth of the caudal pedicle. Fin-fulcra slender, extending up the anterior ray of each median fin. Dorsal fin less than half as long as the back, much elevated in front, arising at the beginning of the second third of the trunk. Scales relatively large and smooth." (A. S. Woodward, *l. c.*, Pt. III, p. 169).

This is a rare form, known only from Cerin, and is not represented in the Bayet Collection.

7. **Ophiopsis macrodus** Thiollière. (Plate LI, fig. 2).

1850. *Ophiopsis macrodus* Thiollière.

Ann. Soc. Sci. Phys. et Nat. Lyon [2] Vol. III, p. 148.

1873. *Ophiopsis macrodus* Thiollière.

Poiss. Foss. Bugey, Pt. II, p. 19.

1895. *Ophiopsis macrodus* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 172.

Type.—Nearly complete fish; Lyons Museum.

A much elongated species of small size, attaining a total length of about 18 cm. Length of head with opercular apparatus equal to the maximum depth of trunk, and contained about five times in the total length; width of caudal pedicle half as great as the maximum depth of trunk. Head and opercular bones smooth, teeth elongate-conical, of relatively very large size and widely spaced. Dorsal fin low, not much extended, and arising at a point about opposite the pelvic pair. Fin-fulcra slender on all the fins, none of which is strongly developed. Scales smooth and relatively small, with entire posterior borders, and in numerous vertical series.

This species has been briefly described but not previously illustrated, and would appear to be a rare form. From the type species, *O. procera*, it is distinguished by the following characters, as noted by the original author:

"L'espèce nouvelle . . . me parait différer de l'*O. procerus* en ce que les dents en sont beaucoup plus fortes et la dorsale bien moins vigoureuse. Les écailles de l'*O. macrodus* ne sont pas, non plus, aussi uniformes que celles de l'espèce de Solenhofen."

A single example of this species is preserved in the Bayet Collection of the Carnegie Museum. It is cataloged as No. 4104, and is shown in the plate. A small example of *Notagogus* is contained in the same slab.

Genus Histionotus Egerton.

"Head large, snout acute; the dorsal margin of the trunk rising above the head to an angulation from which the body gradually tapers backwards. Marginal teeth much elongated, closely arranged. Notochord invested with delicate ring-vertebræ. Fins consisting of distally bifurcating rays, all with large Λ-shaped fulcra; pectoral fins much larger than the pelvic pair; dorsal fin arising at the angulation of the back, extending to the caudal pedicle, high in front, becoming low behind; anal fin small; caudal fin forked. Scales covering the whole of the trunk, in regular series, united by peg-and-socket articulation, and more or less pectinated at the hinder border; [the scales of the middle of the flank and of the dorsal region much deeper than broad, with more or less convex hinder border—*Eastman*]; those of the ventral region at least as broad as deep; postclavicular scales very large; the ridge scales of the caudal pedicle not much enlarged." (A. S. Woodward, *l. c.*, Pt. III, pp. 173–4).

8. **Histionotus falsani** Thiollière. (Plate XLIX, fig. 1).

1873. *Histionotus falsani* Thiollière.

Poiss. Foss. Bugey, Pt. II, p. 14; pl. V, fig. 1.

1895. *Histionotus falsani* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 175.

Type.—Much fractured fish; Lyons Museum.

A species about equalling the type of the genus in size, but the maximum depth of the trunk somewhat exceeding half its length, and the head with opercular apparatus at least as deep as long. Marginal teeth strong and conical, closely crowded. Fulcra prominent on all the fins; scales delicately pectinated along their posterior border.

This species was at first regarded by the original author as identical with *H. angularis* Egerton from the Purbeck of Dorset and Wiltshire. It differs from the latter form, however, and also from *H. oberndorferi* of Wagner, in the less acute angulation of the back, less rapidly tapering posterior region of the trunk, and less coarsely serrated character of the scales.

A single representative of this species, preserved in the collection of the Carnegie Museum, is shown in the plate and is No. 4077. It is nearly as large as the type of the genus, and presents the appearance of having a discontinuous dorsal fin. The resemblance to *Histionotus* in other respects, however, is too close to permit us to doubt that it is properly referred to this genus.

Genus Macrosemius Agassiz.

"Trunk gradually tapering from the occiput backwards; head large, snout acute. Teeth much elongated, closely arranged. Notochord persistent, without ring-vertebræ; ribs ossified. Fins consisting of very robust, bifurcating rays, without fulera except in the caudal; pectoral fins much larger than the pelvic pair; dorsal fin arising immediately behind the occiput and extending continuously to the caudal pedicle; anal fin small; caudal fin rounded. Scales thin and more or less pectinated, with peg-and-socket articulation, and apparently wanting towards the dorsal margin; scales of the middle of the flank relatively large, becoming smaller both dorsally and ventrally, in the former case by dichotomy of the vertical series; about four very large ridge-scales on the ventral border between the anal and caudal fins." (A. S. Woodward, *l. c.*, Pt. III, pp. 176–7).

Three species of *Macrosemius* have been described from the lithographic stone of Cerin under the following names: *M. dumortieri*, *M. fourneti*, and *M. helenæ* Thiollière, the last-named imperfectly defined. A single fragmentary specimen, catalogued as No. 4034, and probably belonging to this genus, is contained in the Bayet Collection.

Genus Notagogus Agassiz.

"A genus scarcely distinguished from *Propterus*, differing only in the non-elongation of the anterior rays of the dorsal fin, which are very widely spaced, and in the less deeply forked character of the caudal fin. The vertebral rings also appear to be more robust than in *Propterus*." (A. S. Woodward, *l. c.*, Pt. III, p. 186).

9. **Notagogus inimontis** Thiollière. (Plate XLIX, fig. 2; Plate L, figs. 1, 2).

1850. *Notagogus imimontis* Thiollière.
Ann. Soc. Sci. Phys. et Nat. Lyon [2] Vol. III, p. 137.

1858. *Notagogus iunismontis* Thiollière.
Bull. Soc. Géol. France [2], Vol. XV, p. 783 (Name only).

1873. *Notagogus inimontis* Thiollière.
Poiss. Foss. Bugey, Pt. II, p. 15; pl. VI, fig. 3.

1893. *Notagogus inimontis* H. E. Sauvage.
Bull. Soc. Hist. Nat. Autun, Vol. VI, p. 428.

1895. *Notagogus inimontis* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. 3, p. 188.

Type.—Nearly complete fish; Lyons Museum.

A small species having about the same form and proportions as *N. denticulatus*,

but distinguished from the latter by its relatively larger teeth and the steeper facial profile of the head. The two portions of the dorsal fin about equally elevated, each with about nine rays, those of the posterior portion more closely approximated than those of the anterior portion. Fulcra well developed on all the median fins. Scales prominently denticulated along the hinder border.

This species is represented in the collections of the Carnegie Museum by several specimens, catalogued under the following numbers: 4033, 4035, 4399, 4418, 4654, 5115, and 5516. The one catalogued as No. 4399 is of unusually large size, approaching that of average specimens of *N. pentlandi*. It bears considerable resemblance to the undescribed form figured by Thiollière under the name of *I. margaritæ*.

10. **Notagogus ornatus** sp. nov. (Pl. L, fig. 3.)

Type.—Nearly complete fish in counterpart; Carnegie Museum Cat. No. 5114 +5114*a*.

A species attaining a length of about 14 cm., of robust proportions and with gently arched dorsal and ventral contours, the length of the head and opercular apparatus equalling the maximum depth of the trunk and contained two and one-half times in the total length, exclusive of the caudal fin. External bones of the head ornamented with delicate striæ, or sometimes with fine vermiculating rugæ. A circumorbital ring present. Jaws powerful, teeth stout, conical, and closely spaced. Dorsal fin extended, but not much elevated, the anterior portion comprising thirteen, and the posterior nine rays. Anal fin arising opposite the hinder part of the posterior dorsal, well developed, and with about eight rays. Caudal fin not deeply forked. Fulcra present on all the median fins.

Scales with numerous fine obliquely directed pectinations along their hinder border; about thirty-six vertical series are to be counted along the lateral line, which is distinctly indicated, and twelve longitudinal series in the deepest part of the trunk. Scales of the pectoral region sharply differentiated by their smaller size and almost cycloidal form from those covering the flanks and abdominal region. A few enlarged ridge-scales at the base of the tail above and below and in advance of the anal fin.

This species is distinguished from *H. inimontis* and the imperfectly known *H. margaritæ*, which accompany it in the Cerin locality, by its larger size, the deeper contour of the body, more numerous dorsal fin-rays, and, as far as may be judged from the published figures of the above-named species, by its scale-characters. Three examples of it are contained in the Bayet Collection of the Carnegie Museum, cataloged as Nos. 5114+5114*a*, 4071, and 4660+4660*a*. The first of these is selected as typical.

Family PYCNODONTIDÆ

"Trunk deeply fusiform or cycloidal. Cranial bones robust, and a median occipital plate separating the parietal elements; facial bones delicate, or wanting; opercular apparatus reduced to a small operculum, large pre-operculum, and not more than two branchiostegal rays; mandibular suspensorium much inclined forwards and gape of mouth small; teeth prehensile on the premaxilla and dentary, wanting on the maxilla (if this bone be present) and the pterygo-palatine arcade; tritoral on the single vomer and the splenials; all the teeth apparently without vertical successors. Notochord persistent, destitute of ossifications in its sheath. Fin-rays robust, the majority well-spaced and articulated; fulcra absent, except perhaps quite at the base of the caudal fin; dorsal and anal fins more or less extended. Scales rhombic when present, frequently wanting on the whole or part of the caudal region; almost invariably strengthened by the inner rib on their anterior margin and united by a peg-and-socket articulation in connection therewith." (A. S. Woodward, *l. c.*, Pt. III, pp. 189–190).

Genus Microdon Agassiz.

"Trunk deeply fusiform, often almost discoidal, with a slender abbreviated caudal pedicle. Head and opercular bones ornamented with reticulating rugæ and pittings; teeth smooth, sometimes feebly indented in the lateral series; vomerine teeth in five longitudinal series, the inner lateral pairs regularly alternating with the widely spaced median teeth; splenial teeth in four series; the innermost being relatively small; the second the largest or principal series. Neural and hæmal arches of axial skeleton of trunk not expanding sufficiently to encircle the notochord. Fin-rays robust, closely articulated, and much divided distally. Pelvic fins present; dorsal and anal fins very high and acuminate in front, rapidly becoming low and fringe-like behind, the former occupying at least the hinder half of the back and the latter somewhat shorter, arising more posteriorly; caudal fin forked. Scales ornamented with reticulating rugæ or pittings, and covering only the anterior half of the trunk in advance of the median fins, though sometimes partly extended over the middle of the flank of the caudal region." (A. S. Woodward, *l. c.*, Pt. III, pp. 221–2).

The type of the genus is *M. elegans* Agassiz.

11. **Microdon bernardi** (Thiollière). (Plate LII, figs. 1 and 2.)

1854. *Pycnodus bernardi* Thiollière.

Poiss. Foss. Bugey, pt. i, p. 17, with plate.

1856. *Microdon bernardi* J. J. Heckel.

Denkschr. K. Akad. Wiss. Wien. Math-Natur. Cl., Vol. XI, p. 201.

1860. *Microdon bernardi* Wagner.

Gelehrte Anzeig. K. Bayer. Akad. Wiss., Vol. I, p. 396.

1895. *Microdon bernardi* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 224.

Type.—Nearly complete fish; Lyons Museum.

A species attaining a total length of about 30 cm. "Maximum depth of trunk equalling about two-thirds of the length of the head and trunk without caudal fin; rostrum prominent, and head with opercular apparatus occupying somewhat less than one-quarter of the total length of the fish. Vertebral axis at origin of dorsal fin midway between the dorsal and ventral borders of the fish. Principal series of mandibular teeth much wider than the two outer series, of which the innermost is insignificant. Dorsal fin occupying considerably more than half of the back, much more elevated than the anal fin, which is also shorter. Ridge-scales delicate on the back, robust but feebly serrated on the ventral border; flank-scales ornamented with delicate radiating rugæ." (A. S. Woodward, *l. c.*, Pt. III, pp. 224–5).

This species is represented in the collection by the following mentioned specimens: Car. Mus. Cat. Nos. 4040, 4084a, 5118, 5132.

12. **Microdon wagneri** (Thiollière). (Pl. LIII, figs. 1 and 2).

1854. *Pycnodus wagneri* Thiollière.

Poiss. Foss. Bugey, Pt. I, p. 23; Pl. V, figs. 1, 2.

1856. *Microdon wagneri* J. J. Heckel.

Denkschr. K. K. Akad. Wiss. Wien, Math-Natur. Cl., Vol. XI, p. 201.

1860. *Microdon wagneri* Wagner.

Gelehrte Anzeig. K. Bayer. Akad. Wiss., Vol. I, p. 396.

1895. *Microdon wagneri* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 225.

Type.—Nearly complete fish; Lyons Museum.

"A species resembling the type, in size, general form, and proportions, and apparently only differing in the extension of the squamation over the middle of of the flank of the anterior half of the caudal region." (A. S. Woodward, *l. c.*, Pt. III, p. 225).

The following mentioned specimens belonging to this species are preserved in the collection of the Museum: Car. Mus. Cat. Nos. 4078, 4090, 4306, 4320.

13. **Microdon egertoni** (Thiollière). (Pl. LIV, fig. 1.)

1854. *Pycnodus egertoni* Thiollière.

Poiss. Foss. Bugey, Pt. I, p. 24, Pl. VII, fig. 2.

1856. *Microdon egertoni* J. J. Heckel.

Denkschr. K. K. Akad. Wiss. Wien, Math-Natur. Cl., Vol. XI, p. 201.

1860. *Microdon egertoni* A. Wagner.

Gelehrte Anzeig. K. Bay. Akad., Vol. I, p. 396.

1895. *Microdon egertoni* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 226.

Type.—Nearly complete fish; Lyons Museum.

A species of small or moderate size, closely resembling *M. elegans*, but stated to be distinguished from it in not exhibiting any angulation of the frontal profile, and in having fewer vertebræ. As remarked, however, by Dr. A. S. Woodward, the first character "may be due to imperfect preservation, and the second is difficult to observe with certainty" (*l. c.*, p. 226).

The following suite of specimens belonging to this species is contained in the collection of the Carnegie Museum: Nos. 4085, 4557, 5106, 5107.

14. **Microdon sauvanausi** (Thiollière). (Plate LIV, fig. 2.)

1850. *Pycnodus sauvanausi* Thiollière.

Ann. Soc. Sci. Phys. et Nat. Lyon [2], Vol. III, p. 131.

1854. *Pycnodus sauvanausii* Thiollière.

Poiss. Foss. Bugey., Pt. I, p. 15, Pl. IV.

1856. *Microdon sauvanausii* J. J. Heckel.

Denkschr. K. K. Akad. Wiss. Wien, Math-Natur. Cl., Vol. XI, p. 201.

1895. *Microdon sauvanausi* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 226.

Type.—Nearly complete fish; Lyons Museum.

"A large species attaining a length of about 60 cm. Maximum depth of trunk apparently equalling about half of the length of the head and trunk without caudal fin; head with opercular apparatus occupying somewhat more than one-quarter of the total length of the fish. Each premaxilla with two chisel-shaped teeth, [other teeth imperfectly known]. Scales apparently confined to the more anterior part of the trunk." (A. S. Woodward, *l. c.*, Pt. III, pp. 225–6).

This species is represented in the Bayet Collection of the Carnegie Museum by a single specimen of moderate size, fairly well preserved, with the exception of the anterior part of the head, and cataloged as No. 4666. This and the next

following species are of interest because they acquaint us with stages showing progressive deepening of the trunk with increasing specialization, *M. itieri* being regarded as a survival of a more primitive type, in which the form of body was elongated and but slightly deepened. A parallel series of modifications is furnished by the genera *Lepidotus* and *Dapedius* among the Semionotidæ, and by typical members of the Palæoniscidæ and Platysomidæ in earlier times.

It is evident that the deep-bodied forms were not adapted for rapid locomotion, and, as indicated by the prevailing type of crushing dentition, they were in all probability bottom-feeders. The large size of the orbits in certain genera occurring at the Solenhofen and Cerin localities suggests that they were probably inhabitants of great depths. Abundant evidence exists, as shown by Dr. Walther and others, to prove that the lithographic stone of Bavaria and southeastern France was deposited under shallow-water conditions, often within lagoons of coral atolls. The presence of a few deep-sea types amid a fauna consisting for the most part of shallow-water inhabitants does not militate against the general theory of the origin of these deposits, but merely bears witness to the fact that the total complex was diversified from time to time by occasional stragglers from outlying regions.

The following remarks by Dr. E. Hennig may be appropriately quoted in connection with this subject:

" Die Pyknodonten sind, nach einem Ausdruck Agassiz's, *poissons broyeurs*, d.h. ihre Nahrung bestand aus Krustazeen, Muscheln, und Schnecken. Die einander entsprechend gewölbten Kauplatten des Ober- und Unterkiefers mit ihren kräftigen, meist in geschlossenen Reihen gestellten Mahlzähnen und die ungewöhnlich starke Abkauung weisen ebenso darauf hin wie die Heranziehung der gesamten unteren Kopfhälfte zur Festigung des Gebisses und die darin zum Ausdruck kommende Konvergenz mit dem lebenden *Anarrhichas lupus*. Auch die weitgehende Differenzierung der Zähne und die zu vermutende Ausschaltung eines häufigeren Zahnwechsels machen eine starke Inanspruchnahme der Kauwerkzeuge in hohem Maase wahrscheinlich.

" Die Beute bestand also auf festsitzenden oder langsam kriechenden Bewohnern des Meeresgrundes und wurde mit den langen und kräftigen Schneidezähnen losgerissen und aufgelesen. Mit dem Aufenthalt zwischen Unebenheiten des Bodens wurde bereits das Aufwärtsrücken des Auges in Verbindung gebracht; auch die hohe Lage der Brustflossen und die Verkümmerung der Bauchflossen dürften in der gleichen Ursache ihre Erklärung finden. Die Grösse der Augen scheint sogar anzudeuten, das die Tiefe, in der die Tiere sich aufhielten, keine unbeträchtliche war. Wenn man auch nicht mit O. Fraas anzunehmen braucht,

dass die lithographischen Schiefer selbst in grösserer Tiefe abgesetzt seien, so stände doch nach der Walterschen Erklärung der Solnhofener Plattenkalke nichts der Ansicht entgegen, dass die[9] Fische aus tieferen Gewässern der Nachbarschaft eingeschleppt worden sind."

15. **Microdon itieiri** (Thiollière).

1850. *Pycnodus itieri* Thiollière.

Ann. Soc. Sci. Phys. et Nat. Lyon [2], Vol. III, p. 132.

1854. *Pycnodus itieri* Thiollière.

Poiss. Foss. Bugey, Pt. I, p. 22, Pl. VI, and two text-figures, p. 23.

1856. *Microdon itieri* J. J. Heckel.

Denkschr. K. K. Akad. Wiss. Wien, Math-Natur. Cl., Vol. XI, p. 201.

1860. *Microdon itieri* A. Wagner.

Gelehrte Anzeig. K. K. Akad. Wiss., Vol. L, p. 396.

1895. *Microdon itieri* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 227.

Type.—Nearly complete fish; Lyons Museum.

"A moderately elongated species, attaining a total length of about 50 cm. Maximum depth of trunk contained three times in the length of the head and trunk without caudal fin; head with opercular apparatus occupying only about one-fifth of the total length of the fish. Vomerine teeth closely arranged; those of the median series much broader than long; those of the inner paired series elongated and their axes oblique, each pair alternating with the median teeth but scarcely pressed between these; outer teeth irregularly quadrate, about as broad as long, and very closely arranged. Splenial teeth (according to Thiollière's diagram) much spaced; those of the principal series two or three times as broad as long, rounded at each end; those of the innermost series minute, and those of the two flanking series somewhat broader than long, the outer twice as large as those of the inner flanking row. Dorsal fin occupying about half of the back, and anal fin more than two-thirds as much extended as this. Scales apparently confined to the most anterior portion of the trunk." (A. S. Woodward, *l. c.*, Pt. III, p. 227).

The form of the body of this species indicates it to be one of the most primitive of the genus and family, possibly a direct descendant of an ancestral type of Pycnodont. It is known only from Cerin, and is not represented in any other than the Lyons Museum.

[9] Hennig, Erwin. Gyrodus und die Organisation der Pycnodonten. Paleontogr., 1906, Vol. LIII, p. 200.

In Part I of Thiollière's Poissons Fossiles de Bugey, p. 23, diagrams are given showing the complete dentition of this species. Several examples of the detached upper and lower dental plates, perhaps referable to this species, are preserved in the collection of the Carnegie Museum, and the most perfect of these is shown of the natural size in the accompanying text-figure.

Fig. 2. Detached splenial dentition of a Pycnodont fish from Cerin, France, provisionally referred to *Microdon itieri* Thioll. × 1/1. Cat. No. 4241.

Family EUGNATHIDÆ.

"Trunk fusiform or elongate, not much laterally compressed. Cranial and facial bones moderately robust, externally enamelled, and opercular apparatus complete; mandibular suspensorium nearly vertical or inclined backwards and gape of mouth wide; snout not produced; premaxillæ in contact mesially and usually separate; marginal teeth conical, and larger than the inner teeth. Notochord usually persistent, the vertebræ rarely more than incomplete rings. Fin-rays robust, articulated, and divided distally; fulcra conspicuous. Dorsal fin short and acuminate. Scales rhombic, sometimes with rounded postero-inferior angle." (A. S. Woodward, *l. c.*, Pt. III, p. 285).

Genus Caturus Agassiz.

"Trunk elongate-fusiform. External head-bones and opercular bones feebly ornamented with rugæ and tuberculations, all except the cheek-plates robust; snout obtusely pointed, and maxilla straight or with a slightly concavely-arched dentigerous border; teeth relatively large and arranged in a sparse series on the margin of the jaws; smaller on the palatine and on the splenial, where they are in single series anteriorly, minute and almost granular on the other inner bones; preoperculum nearly smooth and narrow; operculum deep, much broader below than above, and suboperculum of moderate size. Ossifications in the sheath of the notochord insignificant or absent in the smaller species, consisting only of separate hypocentra and pleurocentra in the largest species; ossified ribs slender, not reaching the ventral border of the abdomen. Fulcra biserial, well-developed on all the fins, those of the pectoral being especially elongated and sometimes in part fused together. Pectoral much exceeding the pelvic fins in size, but the

latter well-developed; dorsal and anal fins triangular in shape, the former arising opposite or immediately behind, the pelvic fins; caudal fin deeply forked. Scales delicate, smooth, feebly crimped or in part tuberculated, deeply overlapping, and none much deeper than broad; a few series anteriorly quadrangular and possibly sometimes united with peg-and-socket, the others more or less cycloidal, and very few narrowed on the ventral aspect of the fish. Lateral line inconspicuous." (A. S. Woodward, *l. c.*, Pt. III, pp. 329–330).

16. **Caturus furcatus** Agassiz. (Plate LV, fig. 1.)

1833. *Pachycormus furcatus* L. Agassiz.
Neues Jahrb., p. 476, and Poiss Foss., Vol. II, Pt. I, p. 11.
1833. *Urœus nuchalis* L. Agassiz.
Neues Jahrb., p. 477, and Poiss. Foss., Vol. II, Pt. I, p. 12.
1834. *Caturus latus* G. von Münster.
Neues Jahrb., p. 539.
1834. *Urœus furcatus* L. Agassiz.
Verhandl. Ges. Vaterländ. Mus. Böhmen, p. 70.
1839. *Caturus maximus* and *macrodus* L. Agassiz.
Neues Jahrb., p. 118.
1839–44. *Caturus latus* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, p. 117; pl. LVI.
1842–44. *Caturus furcatus* L. Agassiz.
Ibid., Pt. II, p. 116; pl. LVI*a*.
1844. *Caturus maximus* and *macrodus* L. Agassiz.
Ibid., Pt. II, pp. 118, 294.
1844. *Caturus nuchalis* L. Agassiz.
Ibid., Pt. II, p. 293.
1863. *Caturus maximus* A. Wagner.
Abh. K. Bay. Akad. Wiss., Math-Phys. Cl., Vol. IX, p. 700.
1863. *Caturus furcatus* A. Wagner.
Ibid., p. 701.
1863. *Caturus latus* and *cyprinoides* A. Wagner.
Ibid., p. 702.
(?) 1873. *Caturus furcatus* Thiollière.
Poiss. Foss. Bugey, Pt. II, p. 18; pl. XIII, fig. 1.
(?) 1873. *Caturus latus* Thiollière.
Ibid., p. 18, pl. XIII, fig. 3.

1881. *Caturus furcatus* B. Vetter.
Mittheil. K. Mineral.-Geol. Mus. Dresden, Pt. IV, p. 109.
1887. *Caturus maximus* K. A. von Zittel.
Handb. Palæont., Vol. III, p. 228, fig. 241 *a*.
1887. *Caturus furcatus* K. A. von Zittel.
Ibid., p. 228, figs. 241 *b–g*.
1887. *Caturus elongatus* K. A. von Zittel.
Ibid., p. 227, fig. 240 (*errore*).
1895. *Caturus furcatus* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 332.

According to the last-named author, the small fishes described under the following names also appear to be immature examples of this species:

1833. *Urœus macrurus* L. Agassiz.
Poiss. Foss., Vol. II, Pt. I, p. 12.
1839. *Caturus microchirus* L. Agassiz.
Neues Jahrb., p. 118.
1842. *Caturus obovatus* G. von Münster.
Neues Jahrb., p. 44.
1844. *Caturus macrurus* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, p. 118.
1844. *Caturus microchirus* L. Agassiz.
Ibid., pp. 118, 294.
1861. *Caturus ferox* Winkler.
Descript. Poiss. Foss. Solenhofen (Natuurk., Verhandl. Holland. Maatsch. [2], Vol. XIV, p. 56, fig. 10).
1863. *Caturus microchirus* A. Wagner.
Abh. K. Bayer. Akad. Wiss., Math-Phys. Cl., Vol. IX, p. 703.
1863. *Caturus macrurus* A. Wagner.
Ibid., p. 706.
1863. *Caturus obovatus* and *gracilis* A. Wagner.
Ibid., p. 707.
1871. *Caturus ferox* Winkler.
Archiv. Mus. Teyler, Vol. III, p. 176; pl. V, figs. 2, 3.

Type.—Nearly complete fish; Royal Bohemian Museum, Prague.

"The type-species attains a length of about one meter. Length of head with opercular apparatus about equal to the maximum depth of the trunk and usually less than one-quarter of the total length of the fish. Caudal region tapering to a

comparatively slender pedicle; its depth little, if at all, exceeding one-third the maximum depth of the abdominal region. Teeth large, with very slender apex, and about forty in total number in the dentary; depth of operculum somewhat exceeding its maximum breadth; branchiostegal rays about twenty-four. Dorsal fin with about twenty rays, deeper than long, its depth equalling about one-half that of the trunk at its origin; this fin arising in advance of the middle of the back, the distance from the occiput to its origin being about equal to that from its hinder border to the base of the caudal fin. Pelvic fins arising opposite the front half of the dorsal fin; anal fin smaller than the dorsal, with from twelve to fourteen rays. Scales smooth, or in part marked with a few feeble, short, transverse striæ." (A. S. Woodward, *l. c.*, Pt. III, p. 333).

The specimens listed below agree with those from Cerin, which are assigned to this species by Thiollière, but the identity of which with the type-species is regarded by Dr. A. S. Woodward as somewhat uncertain: Nos. 4062, 4064, 4074, 4074*a*, 4097, 4300, 4301, 4302, 5108.

17. **Caturus driani** Thiollière.

18. **Caturus velifer** Thiollière.

The two foregoing are large species, occurring in the lithographic stone of Cerin, France, known only by a few examples, and not represented in the collection of the Carnegie Museum, except by one or two obscure fragments (Cat. No. 4089). It may be remarked here that the genus *Callopterus*, two species of which have been described from the Lower Kimmeridgian of Ain, France, is very closely related to *Caturus*, differing only in the more remote position of the dorsal fin, which is almost completely opposed to the anal. No examples of *Callopterus* are preserved in either the British or the Carnegie Museums.

Suborder ÆTHEOSPONDYLI.

"Notochord varying in persistence, but pleurocentra and hypocentra usually fused, never forming alternating discs or rings; tail abbreviate-heterocercal or homocercal. Mandible complex, with well-developed splenial rising into a coronoid process, which is completed by a distinct coronoid bone. Infra-clavicular plates wanting in the pectoral arch; pectoral fin with more than five basals. Scales ganoid." (A. S. Woodward, *l. c.*, Pt. III, p. 415).

Family ASPIDORHYNCHIDÆ.

"Head and trunk much elongated, the snout produced, and the abdominal much longer than the caudal region; tail homocercal. Cranial and facial bones

robust, and opercular apparatus complete, all more or less ganoid, mandibular suspensorium vertical or inclined forwards, but gape of mouth wide; a distinct azygous presymphysial bone present in the mandible; marginal teeth slender, conical. Branchiostegal rays numerous. Vertebral centra annular or amphiocœlous. Fins small, with broad, flattened rays, branched and articulated distally; fulcra minute or absent. Scales rhombic, much deepened on the flank." (A. S. Woodward, *l. c.*, Pt. III, p. 415).

This family, which perhaps may be regarded as ancestral to the modern garpikes (Lepidosteidæ) comprises two genera, which are distinguished by the following differential characters:

"Synopsis of Genera.

Rostrum much produced in advance of mandibular symphysis, and intercalary cheek-plate between the suborbitals and preoperculum; foremost scales of lateral line not deeper than those immediately beneath . . . . . *Aspidorhynchus.*

Rostrum scarcely if at all produced in advance of mandibular symphysis; suborbitals in contact with preoperculum; all scales of lateral line deeper than those immediately beneath. . . . . *Belonostomus.*" (A. S. Woodward, *l. c.*, Pt. III, p. 415).

Genus Belonostomus Agassiz.

"Snout very slender, scarcely if at all produced in front of the extremity of the much-elongated presymphysial bone; cheek-plates robust, the postorbitals extending to the anterior border of the preoperculum; the conical teeth irregular in size, largest on the hinder part of the premaxillæ and the median line of the presymphysial bone, obtuse on the splenial and reduced to a fine granulation on the inner face of the ectopterygoid. Ossified vertebræ usually pierced by a remnant of the notochord. Fin-rays distally bifurcating; fulcra wanting on paired fins, rare on median fins. Pelvic fins situated near the middle of the trunk; dorsal and anal fins short-based, triangular, remote and opposed; caudal fin symmetrically forked. Scales robust, smooth or rugose; in three deepened series on the flank of the abdominal region, and the series traversed by the lateral line the deepest; dorsal scales between the flank scales and the median ridge in two series." (A. S. Woodward, *l. c.*, Pt. III, p. 498).

19. **Belonostomus muensteri** Agassiz. (Plate LV, figs. 2 and 3).

1834. *Aspidorhynchus münsteri* L. Agassiz.

Verhandl. Ges. vaterländ. Mus. Böhmen, p. 70 (name only).

1837. *Belonostomus münsteri* L. Agassiz.

Bericht Versamml. deutsch. Naturf., Jena, 1836, p. 127 (name only).

1844. *Belonostomus münsteri* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, pp. 141, 297, pl. XLVIIa, fig. 2.
1848. *Belonostomus muensteri* C. G. Giebel.
Fauna der Vorwelt, Fische, p. 155.
1861. *Belonostomus münsteri* T. C. Winkler.
Descript. Poiss. Foss. Solenhofen (Natuurk. Verhandl. Holland. Maatsch. [2] Vol. XIV) p. 34, fig. 5.
1863. *Belonostomus münsteri* A. Wagner.
Abh. K. Bay. Akad. Wiss., Math.-Phys. Cl., Vol. IX, p. 689.
1863. *Belonostomus speciosus* A. Wagner.
Ibid., p. 689.
1887. *Belonostomus speciosus* O. Reis.
Sitzungsber. Bay. Akad. Wiss., Math.-Phys. Cl., Vol. XVII, p. 159, pl. I, fig. 4.
1895. *Belonostomus muensteri* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 429.

"*Type.*—Head and anterior part of trunk; British Museum.

A species of moderate size attaining a length of about 40 cm. Head with opercular apparatus occupying about one-quarter of the total length; maximum depth of trunk contained fifteen times in the total length. Cranium about five times as long as its maximum depth, jaws equal in length, the pointed anterior extremity of the dentary bones suturally united with a deep re-entering angle in the pre-symphysial bone; external ornament very finely rugose. Vertebræ in the form of robust constricted rings, longer than deep. Space between the origin of the pelvic fins and that of the anal fin about equal to the space between the latter and the caudal. Scales finely tuberculated, partly rugose; those of the lateral line not much exceeding in depth the series below." (A. S. Woodward, *l. c.*, Pt. III, p. 430).

This species is represented in the collection of the Carnegie Museum by several well-preserved specimens, cataloged under the following numbers: Car. Mus. Cat., Nos. 4043, 4321, 4343, 4653, 5112, 5113, 5133. A distorted and indistinct impression of the trunk belonging to this or a closely related species is cataloged as No. 4068.

20. **Belonostomus tenuirostris** Agassiz. (Plate LI, fig. 3).

1833. *Aspidorhynchus tenuirostris* L. Agassiz.
Poiss. Foss., Vol. II, Pt. I, p. 14.
1834. *Belonostomus tenuirostris* L. Agassiz.
Neues Jahrb., p. 388.

1837. *Belonostomus tenuirostris* L. Agassiz.
Bericht Versamml. deutsch. Naturf., Jena, 1836, p. 127.
1837. *Belonostomus tabulatus* L. Agassiz.
Ibid., p. 127 (name only).
1844. *Belonostomus tenuirostris* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, pp. 143, 297.
1844. *Belonostomus subulatus* L. Agassiz.
Ibid., pp. 143, 297.
1863. *Belonostomus tenuirostris* A. Wagner.
Abh. K. Bay Akad. Wiss., Math.-Phys., Cl., Vol. IX, p. 691.
1863. *Belonostomus tenuirostris* var. *brevivertebralis* A. Wagner.
Ibid., p. 691.
1873. *Belonostomus tenuirostris* V. Thiollière, *ed.* P. Gervais.
Poiss. Foss. Bugey, Pt. II, p. 24.
1881. *Belonostomus tenuirostris* B. Vetter.
Mittheil. K. Mineral-geol. Mus. Dresden, Pt. IV, p. 85.
895. *Belonostomus tenuirostris* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 431.
1912. *Belonostomus tenuirostris juv.* C. R. Eastman.
Ann. Carnegie Mus., Vol. VIII, p. 184, pl. X.

Type.—Incomplete fish; present location unknown.

"A species of very slender proportions attaining a length of about 30 cm. Head with opercular apparatus occupying one-third of the total length; maximum depth of trunk contained fourteen times in the total length. Cranium about nine times as long as its maximum depth, having the snout excessively elongated and projecting to some extent in advance of the anterior extremity of the mandible; the pointed front end of the dentary bones suturally united with a deep re-entering angle in the pre-symphysial bone; superficial ornament consisting of delicate rugæ. Vertebræ in the form of separated narrow rings, much deeper than broad. Scales smooth or feebly tuberculated and rugose; those of the lateral line not much exceeding in depth the series below." (A. S. Woodward, *l. c.*, Pt. III, p. 431–2).

Thiollière's recognition of this species in the paleichthyic fauna of Cerin is stated to have been based upon two specimens showing the head, in which the rostrum projects considerably in advance of the anterior extremity of the mandible. A single specimen in the Carnegie Museum, catalogued as No. 4080, seems referable to this species, judging from the characters of the head, proportions of the anterior part of the trunk (which lacks the caudal region), and depth of the vertebral rings.

The small and incomplete fish, which is illustrated in the accompanying plate, possesses unusual interest on account of its containing within the abdominal cavity a well preserved skeleton of a small Rhynchocephalian reptile. The prey had been swallowed head first, and may have caused the death of the fish, as digestion had not proceeded far enough to dismember the limbs nor to disturb the natural position of the body-parts of the reptile, beyond a slight lateral compression of the trunk. The head, notwithstanding its small size, is very well preserved, a fact which is the more remarkable, when we consider the peculiar conditions which have revealed to us the fate of both creatures. In the case of the reptile, which is probably a young *Homœosaurus*, certain of the cranial elements and vacuities are distinguishable as well as the sensory canals and even a few minute teeth. So far as the writer is aware, paleontology affords no other instance of a fossil reptile enclosed within the digestive tract of a fish.

The apparent anomaly of finding a land reptile within the body of a marine fish may be accounted for by supposing the former to have been a shore-inhabitant of a coral island, thus resembling the modern *Sphenodon* in habitat. The creature may have been carried out to sea by floating vegetation, and been seized at a distance from land by a marine carnivorous fish. The proximity of land to the locality when the deposits at Cerin were laid down is indicated by a considerable quantity of plant remains, which have been described by Count G. de Saporta.

An exceedingly well preserved example, which has been chosen for the purpose of illustrating the characters of the adult of this species, is that shown in Plate LI, fig. 3, which belongs to the Museum of Comparative Zoology at Cambridge, Massachusetts.

Suborder *ISOSPONDYLI*.

"Notochord varying in persistence, the vertebral centra usually complete, but none coalesced; tail homocercal, but hæmal supports not much expanded or fused. Symplectic bone present; mandible simple, each ramus consisting only of two elements (dentary and articulo-angular), with rare rudiments of a splenial on the inner side. Pectoral arch suspended from the cranium; a precoracoid arch present, infraclavicular plates wanting; pectoral fin with not more than four or five basals. Pelvic fins abdominal. Scales ganoid only in the less specialized families." (A. S. Woodward, *l. c.*, Pt. III, p. 446).

Family PHOLIDOPHORIDÆ.

"Trunk elegantly fusiform. Head with delicate membrane-bones, the suborbital and circumorbital plates completely covering the cheek, all enamelled; snout

not produced; mandibular suspensorium nearly vertical or inclined forwards, and gape of mouth wide; premaxilla very small; maxilla large, loosely attached and with two well-developed supramaxillary plates; teeth small and conical. Opercular apparatus complete. Vertebral centra never advanced beyond the annular stage; ribs delicate; no fused nor expanded hæmal arches at the base of the tail. Intermuscular bones absent. Fin-fulcra present, but usually small; dorsal and anal fins small, the former above or behind the pelvic fins. Scales ganoid, more or less rhombic, but deeply overlapping, and the hinder margin often somewhat rounded." (A. S. Woodward, *l. c.*, Pt. III, p. 446–7).

Genus Pholidophorus Agassiz.

"Trunk not much deepened, and head relatively large. External bones smooth or delicately ornamented with rugæ and tuberculations; sensory canal on suborbital and preorbital plates branched; maxilla more or less arched, the oval margin convex and provided with minute teeth; mandibular teeth larger, but still minute and arranged in a single series. Preoperculum broad mesially and marked with slight radiating furrows; suboperculum large, but smaller than the trapezoidal operculum, from which it is divided by an oblique suture; branchiostegal rays numerous. Pleurocentra and hypocentra in notochordal sheath fused or separate. Fin-fulcra small, extending along the foremost ray of each of the fins. Pectoral not excessively large, but much exceeding the pelvic fins in size; dorsal and anal fins triangular in shape, not extended, the former opposite or arising somewhat behind the pelvic fins; caudal fin deeply forked. Scales thin, deeply overlapping, usually with an inner rib and peg-and-socket articulation, and the external layer of ganoine smooth or feebly ornamented; principal flank-scales deeper than broad, ventral scales in part broader than deep; no enlarged series of ridge-scales, but a large scale at the base of one or both lobes of the caudal fin, and three slightly enlarged scales round the anus at the base of the anal fin. Lateral line opening by widely separated large pores." (A. S. Woodward, *l. c.*, pp. 447–8).

The occurrence of this genus in the Lithographic Stone at Cerin was first reported by Thiollière, who recognized what he considered to be three new species, without, however, describing or naming them. Wagner, in 1860, recorded the presence of his newly described *P. ovatus* in the Cerin deposits, an identification concerning which later writers appear to have entertained some doubt. The only scientifically described species of this genus occurring at the Cerin locality is *P. similis*.

21. **Pholidophorus similis** A. S. Woodward. (Pl. LVI, fig. 1).

1895. *Pholidophorus similis* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 470, pl. XIII, fig. 2.

Type.—Nearly complete fish; British Museum.

A species attaining a length of about 20 cm. "Length of head with opercular apparatus nearly equalling the maximum depth of the trunk, which is contained from four-and-a-half to five times in the total length of the fish. Head and opercular bones very finely rugose. Fin-rays stout and smooth. Pelvic fins arising far in advance of the middle point of the trunk, and the dorsal fin opposed to them. Scales large, ornamented with fine oblique striations, more or less radiating, and terminating at the hinder margin in denticulations; several series of flank-scales deeper than broad; the orifices of the lateral line inconspicuous." (A. S. Woodward, *l. c.*, Pt. III, p. 470).

The undermentioned examples are representative of this species in the collections of the Carnegie Museum. Car. Mus. Cat., Nos. 4063, 4069, 4081, 4082, 4095, 4326, 4661, 4667.

22. **Pholidophorus ovatus** Wagner.

1863. *Pholidophorus ovatus* A. Wagner.

Abh. Bay. Akad., Wiss., math.-phys. Cl., Vol. IX, p. 666.

1895. *Pholidophorus ovatus* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 471.

"*Type.*—Fish with imperfect median fins; Paleontological Museum, Munich.

A robust species attaining a length of about 18 cm., not yet clearly distinguished from *P. granulatus*, but perhaps with a somewhat less deepened trunk. Fin-rays smooth and stout; fulcra conspicuous. Fins and scales as in the preceding species." (A. S. Woodward, *l. c.*, Pt. III, p. 471).

A single, moderate-sized, incompletely preserved example, cataloged as No. 4073, and probably referable to this species, is contained in the Bayet Collection.

Genus Pleuropholis Egerton.

"Trunk elongate-fusiform, and upper caudal lobe conspicuous. External bones smooth or delicately ornamented with rugæ and tuberculations; maxilla more or less arched and the oval margin convex; teeth minute. Vertebral centra annular. Fulcra present on all the fins. Pelvic fins well developed, but smaller than the pectorals; dorsal and anal fins longer than deep, opposite. Scales thick and moderately overlapping; those of the middle of the flank excessively deepened, covering nearly the whole of it, each strengthened within by a broad rib and exhibit-

ing a peg-and-socket articulation; dorsal and ventral scales few, relatively small and rhomboidal. Lateral line deflected, passing down the second or third deepened flank-scale and then traversing the uppermost series of small ventral scales." (A. S. Woodward, *l. c.*, Pt. III, p. 482–3).

23. **Pleuropholis thiollieri** Sauvage.

1873. *Pleurophoilis* V. Thiollière.

Poiss. Foss. Bugey, Pt. II, pl. VI, fig. 6.

1883. *Pleuropholis thiollieri* H. E. Sauvage.

Bull. Soc. Géol. France [3], Vol. XI, p. 499.

1895. *Pleuropholis thiollieri* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, pp. 485–6.

"*Type.*—Nearly complete fish; Lyons Museum.

A species attaining a length of about 12 cm. Length of head with opercular apparatus about equalling the maximum depth of the trunk and contained nearly five-and-a-half times in the total length of the fish; caudal pedicle slender, its width equalling two-thirds the depth of the flank-scales in the middle of the abdominal region. Pelvic fins arising midway between the pectorals and the anal; the latter fin arising slightly behind the middle point between the pectorals and the caudal. Scales smooth, not serrated." (A. S. Woodward, *l. c.*, Pt. III, pp, 485–6).

This species is represented in the collection by two individuals of average size, cataloged as Nos. 4318 and 4322. A smaller example, cataloged as No. 4032, is perhaps also referable to the same species. This latter is of about the same size as the unnamed original of Thiollière's Plate VI, fig. 5, a specimen which was subsequently described by Sauvage (Bull. Soc. Geol. France [3] Vol. XI, 1883, p. 498; pl. XIII, fig. 1) under the preoccupied title of *P. egertoni*. According to Dr. A. S. Woodward, the original of Thiollière's and Sauvage's illustrations is indistinguishable from *P. serrata* Egerton. In whatever way we may regard the identity of Thiollière's original (Poiss. Foss., Pt. II, 1873, pl. VI, fig. 5) the specimen bearing the Carnegie Museum Catalog Number 4032 differs from it in the non-serrated condition of the principal flank-scales.

Family OLIGOPLEURIDÆ.

"Trunk fusiform. Head with delicate membrane bones, scarcely, if at all, enamelled; mandibular suspensorium nearly vertical or inclined forwards, and gape of mouth wide; teeth small or of moderate size. Vertebral centra well-ossified, with no distinct pleurocentra and hypocentra in any part of the column; large free

neural spines in the abdominal region; ribs short; no fused or expanded hæmal arches at the base of the tail. Intermuscular bones rare or absent. Fin-fulcra present; dorsal and anal fins acuminate in front, of variable length. Scales thin, more or less rounded, and deeply imbricating." (A. S. Woodward, *l. c.*, Pt. III, p. 490).

Genus Œonoscopus Costa.

(Syn. *Attakeopsis* V. Thiollière; *Macrorhipis* A. Wagner.)

"Head large and snout pointed; maxilla much deepened behind, with nearly straight dentigerous border; teeth of moderate size, stout and conical or styliform. Vertebral centra usually about as long as deep, and the side of each exhibiting a median longitudinal ridge with a deep pit above and below; ribs robust, but short. Fin-rays robust, all closely articulated and divided at some distance from the base; fulcra conspicuous on the median fins. Dorsal and anal fins short-based, the former almost or completely in advance of the latter; caudal fin much forked. Scales large." (A. S. Woodward, *l. c.*, Pt. III, pp. 494–5).

24. **Œonoscopus desori** (Thiollière).

1858. *Attakeopsis desori* Thiollière.
Bull. Soc. Géol. France [2] Vol. XV, p. 784 (name only).
1873. *Attakeopsis desori* Thiollière.
Poiss. Foss. Bugey, Pt. II, p. 23, pl. XI.
1887. *Œonoscopus desori* K. A. von Zittel.
Handb. Paleont., Vol. III, p. 232.
1895. *Œonoscopus desori* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 497.

Type.—Nearly complete fish; Lyons Museum.

This species, regarded by Thiollière as the type of a distinct genus, named by him *Attakeopsis*, is of moderate size, attaining a length of about 35 cm. Length of head with opercular apparatus nearly equal to the maximum depth of the trunk and contained somewhat more than four times in the total length of the fish; caudal pedicle less than half as deep as the abdominal region. Teeth closely arranged in the maxilla and dentary. Vertebræ not more than 50 in number and mostly as long as deep. Pelvic fins arising at a point about midway between the pectorals and anal fin; median fins as in *O. cyprinoides*.

An excellent figure of an example of this species, without description, is given in the posthumous work of Thiollière, published in 1873. A single specimen is recorded in Dr. Woodward's Catalogue as belonging to the British Museum. Two

representatives of this species are contained in the collections of the Carnegie Museum, one having a length of 17 cm. and the other of 28 cm. These bear the catalog numbers 4303 and 4432 respectively. The former of these displays the undigested remains of a small vertebrate, probably a lizard-like reptile, within the abdominal cavity. Either the vertebral column of the enclosed prey has been flexed upon itself, or there are two small creatures to be seen within the body of the fish.

25. **Œonoscopus elongatus** Eastman. (Plate LVI, figs. 2 and 3).

1912. *Œonoscopus elongatus* C. R. Eastman.

Ann. Carnegie Mus., Vol. VIII, p. 185, pl. XI.

Type.—Nearly complete fish in counterpart: Carnegie Museum Catalogue No. 4079+4079*a*.

A small-sized species, attaining a length of about 20 cm. and distinguished from all others belonging to the same genus by its slender and elongated form of body, and by the more forward position of the dorsal fin, which arises opposite the pelvics, and does not extend back of a point midway between them and the origin of the anal. Length of the head with opercular apparatus exceeding the maximum depth of trunk, and contained about five times in the total length of the fish. Vertebræ about 50 in number, with strong neural and hæmal spines. A single large ridge-scale at the upper and lower borders of the caudal pedicle. Teeth small and conical. All fins relatively small, caudal lobes not much expanded.

The holotype of this species is a nearly complete fish preserved in counterpart, cataloged as No. 4079+4079*a*. It has a total length of 19 cm., and is interesting for containing apparently a small Rhynchocephalian reptile within the abdominal cavity. Another example, cataloged as No. 4088, is about one-third smaller than the type and is complete except for the anterior margin of the head, which is wanting. Three small specimens of *Leptolepis* are preserved in the same slab, one either superimposed over the body of the large fish in a longitudinal direction, or contained inside.

Family LEPTOLEPIDÆ.

"Trunk elegantly fusiform. Head with delicate membrane-bones, the suborbital and circumorbital plates almost or completely covering the cheek, more or less enamelled; parietal bones meeting in the middle line; snout not produced; mandibular suspensorium nearly vertical or inclined forwards, but gape of mouth wide; premaxilla very small; maxilla large, loosely attached and with two well-developed supramaxillary plates; teeth small and conical. Opercular apparatus complete. Vertebral centra well ossified, but always pierced by the notochord; ribs delicate;

no fused or expanded hæmal arches at the base of the tail. Intermuscular bones present. Fin-fulcra absent; fin-rays more or less divided and articulated distally; dorsal and anal fins small, the former usually short-based, above or behind the pelvic pair. Scales thin, cycloidal and deeply imbricating, usually ganoid in their exposed portion; lateral line not observable." (A. S. Woodward, *l. c.*, Pt. III, p. 500).

Genus Leptolepis Agassiz.

"Head large and teeth minute; sclerotic ossified. Maxilla arched, with a slightly convex dentigerous border; mandible prominent, and dentary sharply rising into a thickened, obtuse elevation near its anterior extremity; preoperculum broad mesially, with a large inferior limb, marked with radiating ridges; subopercular large, but smaller than the trapezoidal operculum, from which it is divided by an oblique suture. Vertebræ in the form of much-constricted cylinders, with little or no secondary ossification. Pelvic fins relatively large; dorsal fin about as long as deep, opposed to the pelvic pair or to the space between the latter and the anal; anal fin small, not much extended; caudal fin deeply forked. Scales completely covering the trunk; no enlarged or thickened ridge-scales." (A. S. Woodward. *l. c.*, P. III, p. 501).

26. **Leptolepis sprattiformis** (Blainville).

1755. Figure by G. W. Knorr.
Samml. Merkwürdigk. Natur, pl. XXIII, figs. 2, 3; pl. XXVIII, fig. 3; pl. XXIX, figs. 2–4.

1818. *Clupea sprattiformis* H. D. de Blainville.
Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 330.

(?) 1839. *Leptolepis pusillus* G. von Münster.
Neues Jahrb., p. 680.

1833–44. *Leptolepis sprattiformis* L. Agassiz.
Poiss. Foss., Vol. II, Pt. I, p. 13; Pt. II, pp. 130, 294, pl. LXI*a*, fig. 1.

1839–44. *Leptolepis macrolepidotus* L. Agassiz.
Ibid., Pt. II, p. 132, pl. LXI, figs. 4–6.

1863. *Leptolepis sprattiformis* A. Wagner.
Abh. K. Bay. Akad. Wiss., Math.-Phys., Cl., Vol. IX, pp. 741, 744.

1888. *Leptolepis sprattiformis* K. A. von Zittel.
Handb. Paläont., Vol. III, p. 272, fig. 279.

1895. *Leptolepis sprattiformis* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 513.

Type.—Nearly complete fish; Museum of Natural History, Paris.

The occurrence of this species in the Lithographic Stone of Cerin, France, is reported by Thiollière in the faunal list included in his posthumous work of 1873. A considerable number of small and indistinct impressions which may be referred to this species, or may be the fry of some other Leptolepid, are contained in the Bayet Collection. A slab in which several are to be seen has already been spoken of in connection with a specimen of *Œonoscopus elongatus* (No. 4088), which apparently contains one of the small fry inside.

27. **Leptolepis dubia** (Blainville). (Plate LI, Fig. 1).

1818. *Clupea dubia* H. D. de Blainville.

Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 331.

1833–44. *Leptolepis dubius* L. Agassiz.

Poiss. Foss., Vol. II, Pt. I, p. 13; Pt. II, pp. 134, 294 (in part).

1895. *Leptolepis dubius* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 509, pl. XIV, figs. 6, 7.

Type.—Nearly complete fish; Museum of Natural History, Paris.

This is a large and robust species, attaining a length of about 30 cm., and very abundant in the Lithographic Stone of Bavaria. It has not hitherto been reported from other localities than in the neighborhood of Solenhofen and Eichstädt, but there is one example in the Bayet Collection of the Carnegie Museum which is evidently referable to this species, and is figured in the accompanying plates. It is from the Upper Jura of Cerin, France, and, together with the smaller species of the same genus, serves to illustrate the close correspondence existing between the faunæ of the respective localities. The figured specimen is cataloged as No. 4396.

Genus Thrissops Agassiz.

"Head small and teeth minute; sclerotic ossified. Maxilla arched, with a slightly convex dentigerous border; mandible prominent, the dentary apparently intermediate in form between that of *Leptolepis* and *Æthalion*. Opercular apparatus as in *Leptolepis*. Vertebral centra well ossified, strengthened by a median lateral ridge; the free neural arches in the abdominal region much elongated and thickened, the ribs also especially robust. Pelvic fins much smaller than the pectorals; dorsal fin small and short-based, opposite to the anal fin, which is acuminate in front, and much extended behind; caudal fin forked. Scales completely covering the trunk; no enlarged or thickened ridge-scales." (A. S. Woodward, *l. c.*, Pt. III, p. 521).

28. **Thrissops formosus** Agassiz.

1833–44. *Thrissops formosus* L. Agassiz.
Poiss. Foss., Vol. II, pt. I, p. 12; Pt. II, p. 124, pl. LXV*a*.
1844. *Thrissops subovatus* L. Agassiz (*ex* Münster MS.).
Ibid., Pt. II, p. 128 (undefined).
1839. *Thrissops ovatus* G. von Münster.
Neues Jahrb., p. 680.
1852. *Thrissops formosus* F. A. Quenstedt.
Handb. Petrefakt., p. 219, pl. XVII, fig. 19.
1863. *Thrissops formosus* A. Wagner.
Abh. K. Bayer. Akad. Wiss., Math.-Phys. Cl., Vol. IX, p. 734.
1863. *Thrissops subovatus* A. Wagner.
Ibid., p. 734.
1888. *Thrissops formosus* K. A. von Zittel.
Handb. Paläont., Vol. III, p. 273, figs. 280, 281.
1895. *Thrissops formosus* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 521.

"*Type.*—Nearly complete fish; Paleontological Museum, Munich.

The type-species, attaining a length of about 50 cm. Head with opercular apparatus occupying from one-eighth to one-seventh of the total length of the fish; maximum depth of trunk much exceeding the length of the head with opercular apparatus, and contained about three-and-a-half times in the length of the trunk from the pectoral arch to the base of the caudal fin. Vertebræ at least 60 in number, about 32 being abdominal and 28 caudal. Pelvic fins arising much nearer to the anal than to the pectorals, and comprising about 5 rays; dorsal fin with 14 rays, arising somewhat behind the origin of the anal, which is much elevated in front and comprises not less than 30 rays; caudal fin very deeply forked and the lobes slender. Scales partly ornamented with delicate radiating striæ." (A. S. Woodward, *l. c.*, Pt. III, p. 521).

A single undoubted representative of this species, which has not been heretofore reported from the French lithographic limestone, forms part of the Bayet Collection in the Carnegie Museum, and is cataloged as No. 4083. It has a total length of about 34 cm., the extremity of the tail being preserved in impression.

29. **Thrissops regleyi** Thiollière.

1854. *Thrissops regleyi* Thiollière.
Poiss. Foss. Bugey, Pt. I, pl. X, fig. 2 (figure only).

1861. *Thrissops clupeoides* Winkler.

Natuurk. Verhandl. Holland. Maatsch. [2] Vol. XIV, p. 21, fig. 3.

1895. *Thrissops clupeoides* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 523.

Type.—Nearly complete fish; Lyons Museum.

A species attaining a length of about 25 cm. Head with opercular apparatus contained about four times in the total length exclusive of the caudal fin, and equalling the maximum depth of the trunk. Vertebræ about 50 in number, of which 25 are caudal. Fins as in the type-species, except that the caudal is much less deeply forked and with broader lobes. Lower limb of the preoperculum ornamented with about ten fine radiating elevated ridges.

30. **Thrissops heckeli** Thiollière.

1854. *Thrissops heckeli* Thiollière.

Poiss. Foss. Bugey, Pt. I, pl. X, fig. 1 (no description).

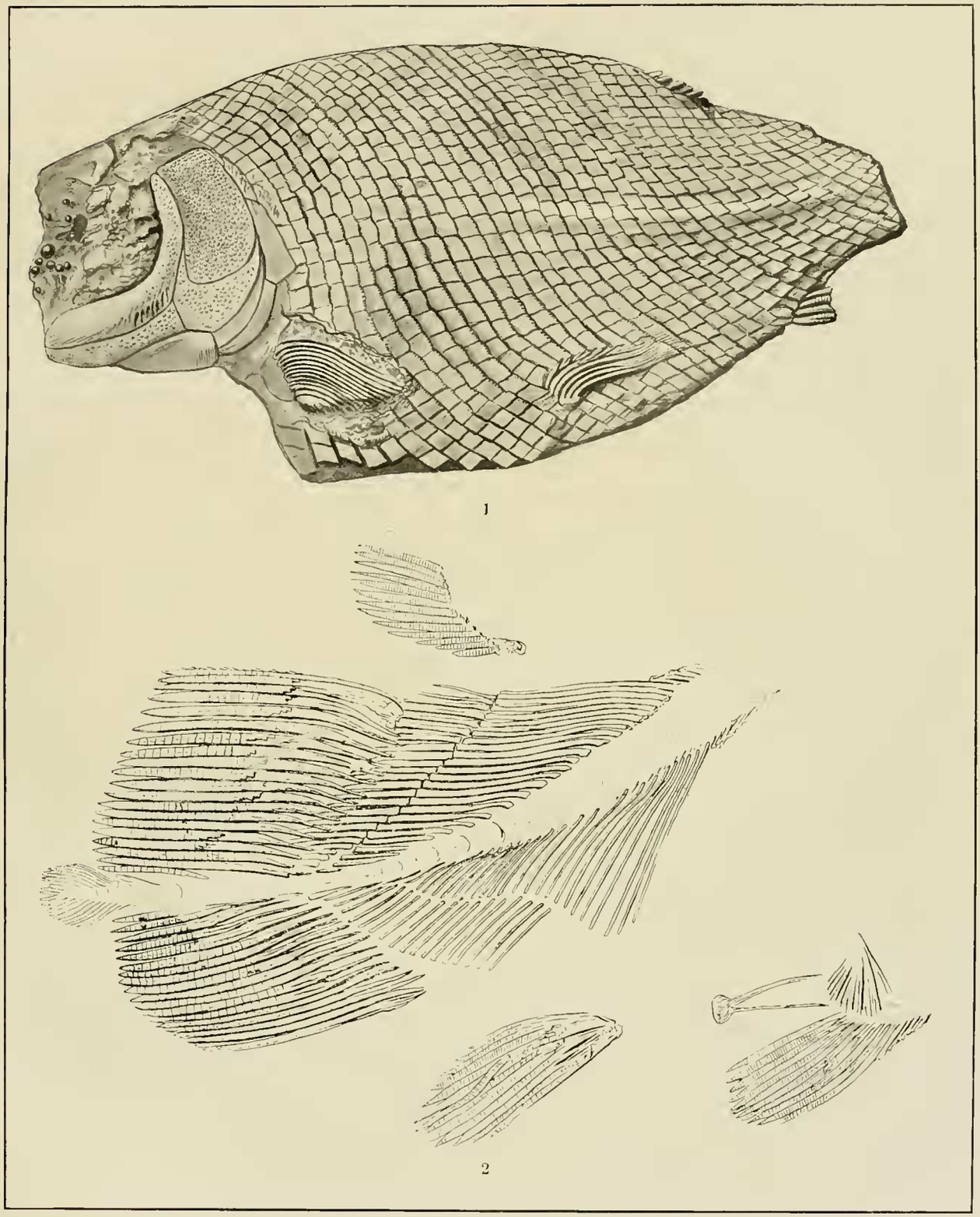
1895. *Thrissops heckeli* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 527.

Type.—Contorted large fish; Lyons Museum.

The holotype of this undescribed species is a large specimen having a total length of about 73 cm. It is slender and elongate in form, the proportions resembling those of *T. formosus*, but the pectoral and caudal fins are much more strongly developed than in that species, and the lobes of the tail are narrower and longer.

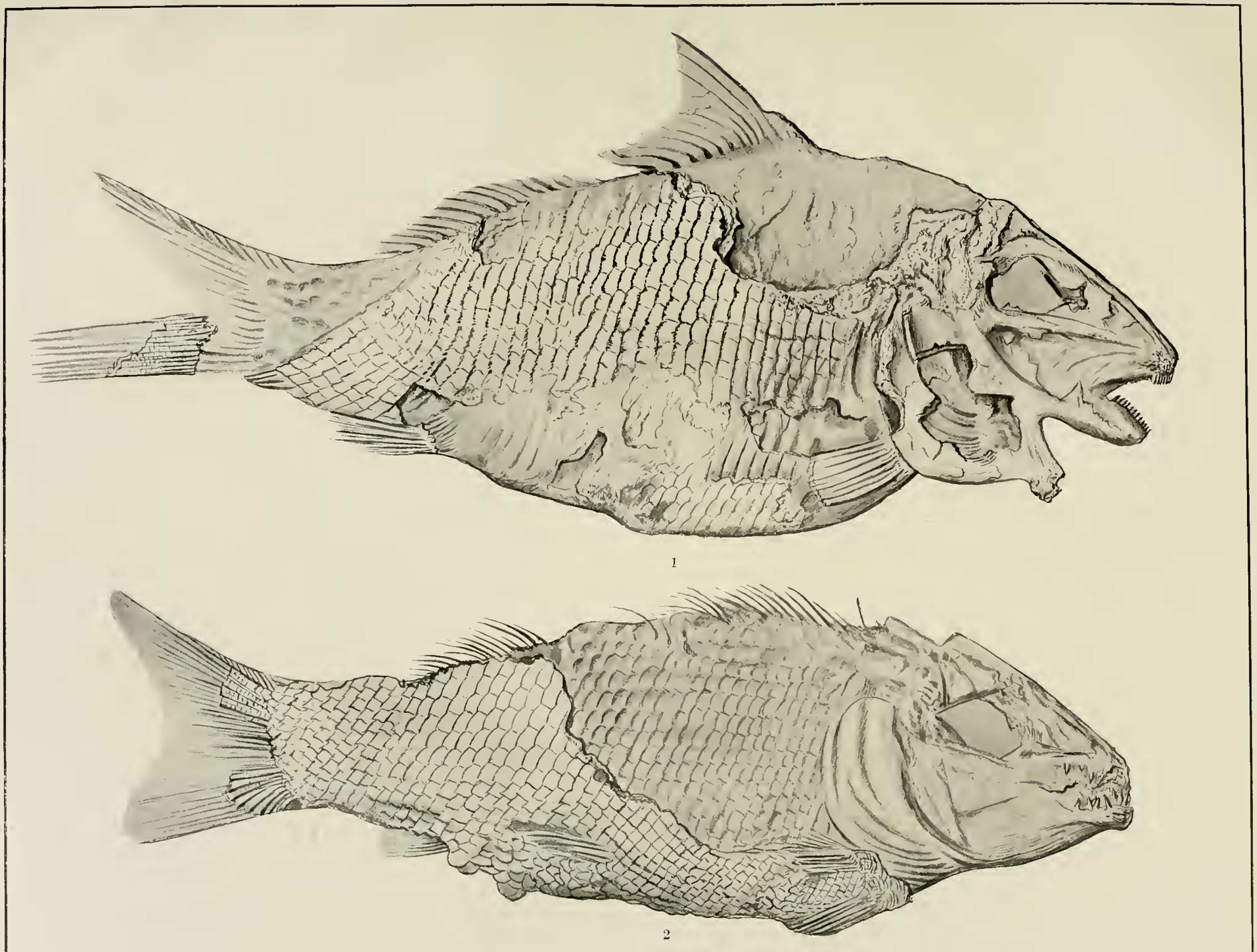
A single specimen in the collection of the Carnegie Museum, cataloged as No. 4091, is apparently referable to this species. It shows the head-region with the opercular apparatus, together with the powerful pectoral fin of the left-hand side, in which thirteen extremely stout rays are to be counted, decreasing in length gradually in a posterior direction.



1

2

FIG. 1. *Lepidotus lævis* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 5130. $\times \frac{1}{3}$.
FIG. 2. *Undina grandis* SP. NOV. C. M. CAT. FOSS. FISHES, NO. 4748. $\times \frac{1}{3}$.



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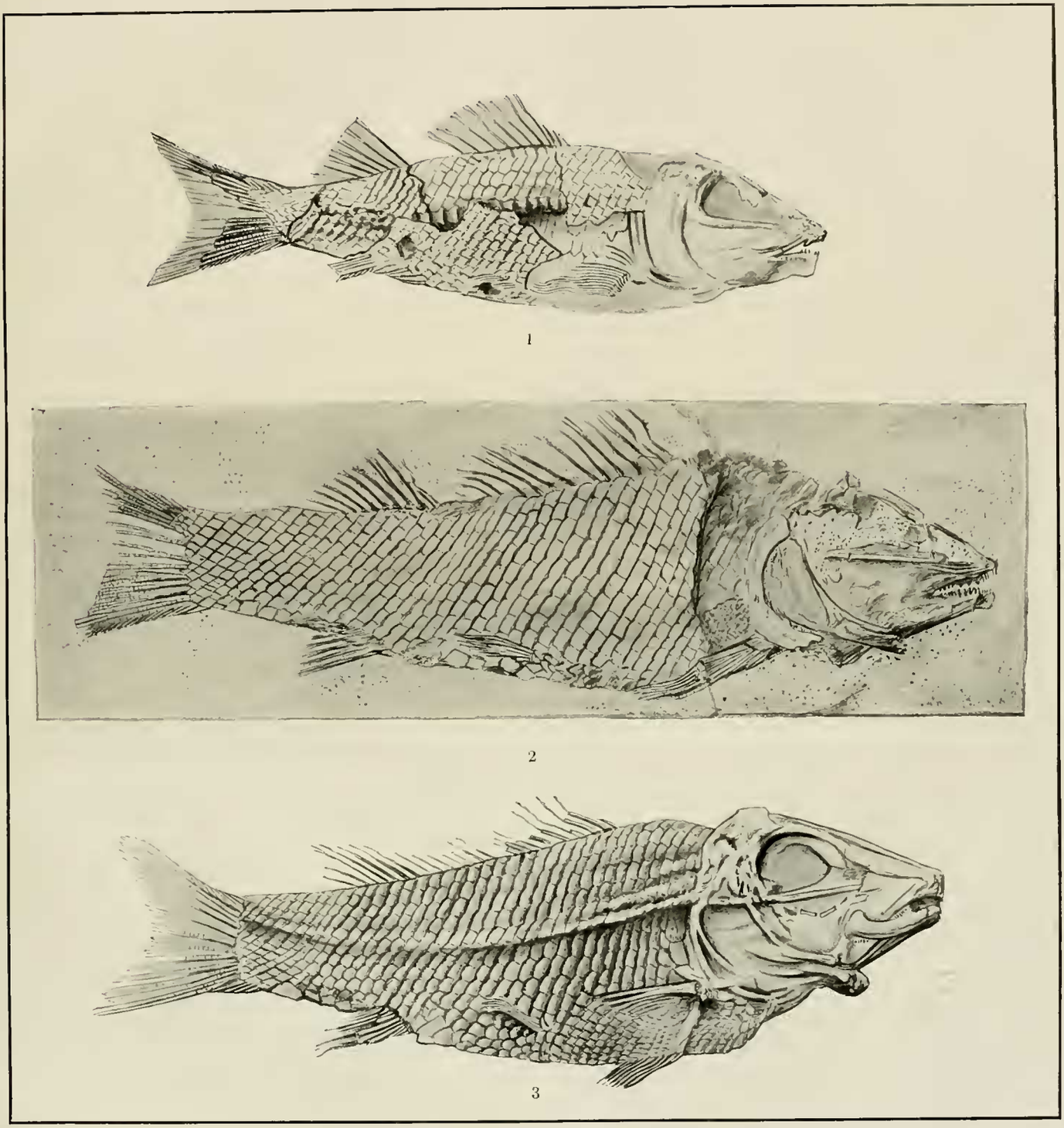
2

FIG. 1. *Histionotus falsani* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 4077. $\times \frac{3}{2}$.
FIG. 2. *Notagogus inimontis* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 4660a. $\times \frac{3}{2}$.



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2

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FIG. 1. *Notagogus inimontis* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 5115. $\times \frac{3}{2}$.
FIG. 2. *Notagogus inimontis* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 4399. $\times \frac{3}{2}$.
FIG. 3. *Notagogus ornatus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 5114a. $\times \frac{3}{2}$.

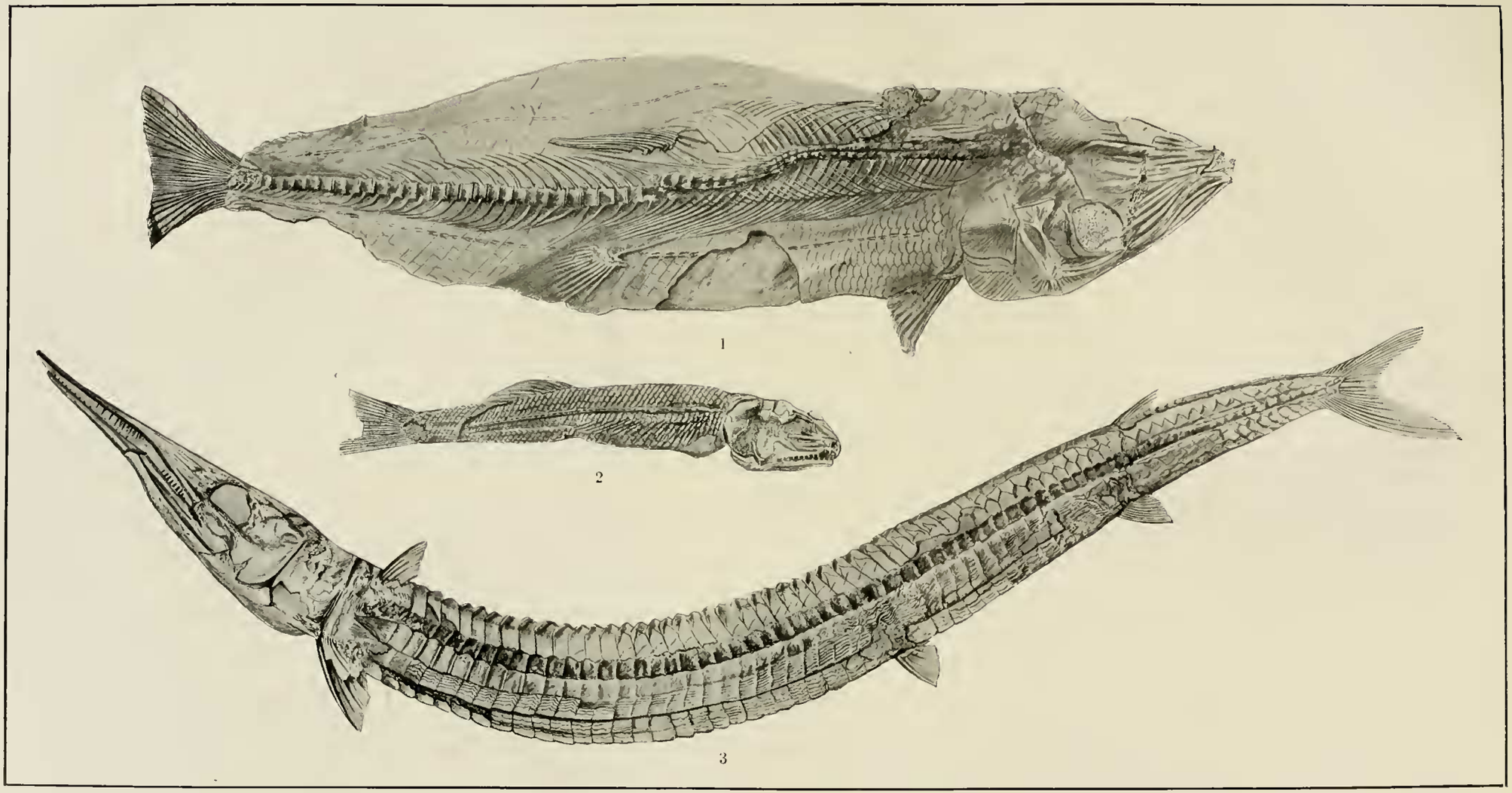

FIG. 1. *Leptolepis dubia* (BLAINVILLE). C. M. CAT. FOSS. FISHES, NO. 4396. $\times \frac{1}{1}$.
FIG. 2. *Ophiopsis macrodus* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, NO. 4104. $\times \frac{1}{1}$ CIRCA.
FIG. 3. *Belenostomus tenuirostris* AGASSIZ. MUS. COMP. ZOÖL., HARVARD UNIV. $\times \frac{1}{1}$ CIRCA.

FIG. 1. *Microdon bernardi* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, No. 4084. $\times \frac{64}{100}$.
FIG. 2. *Microdon bernardi* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, No. 5118. $\times \frac{1}{5}$.

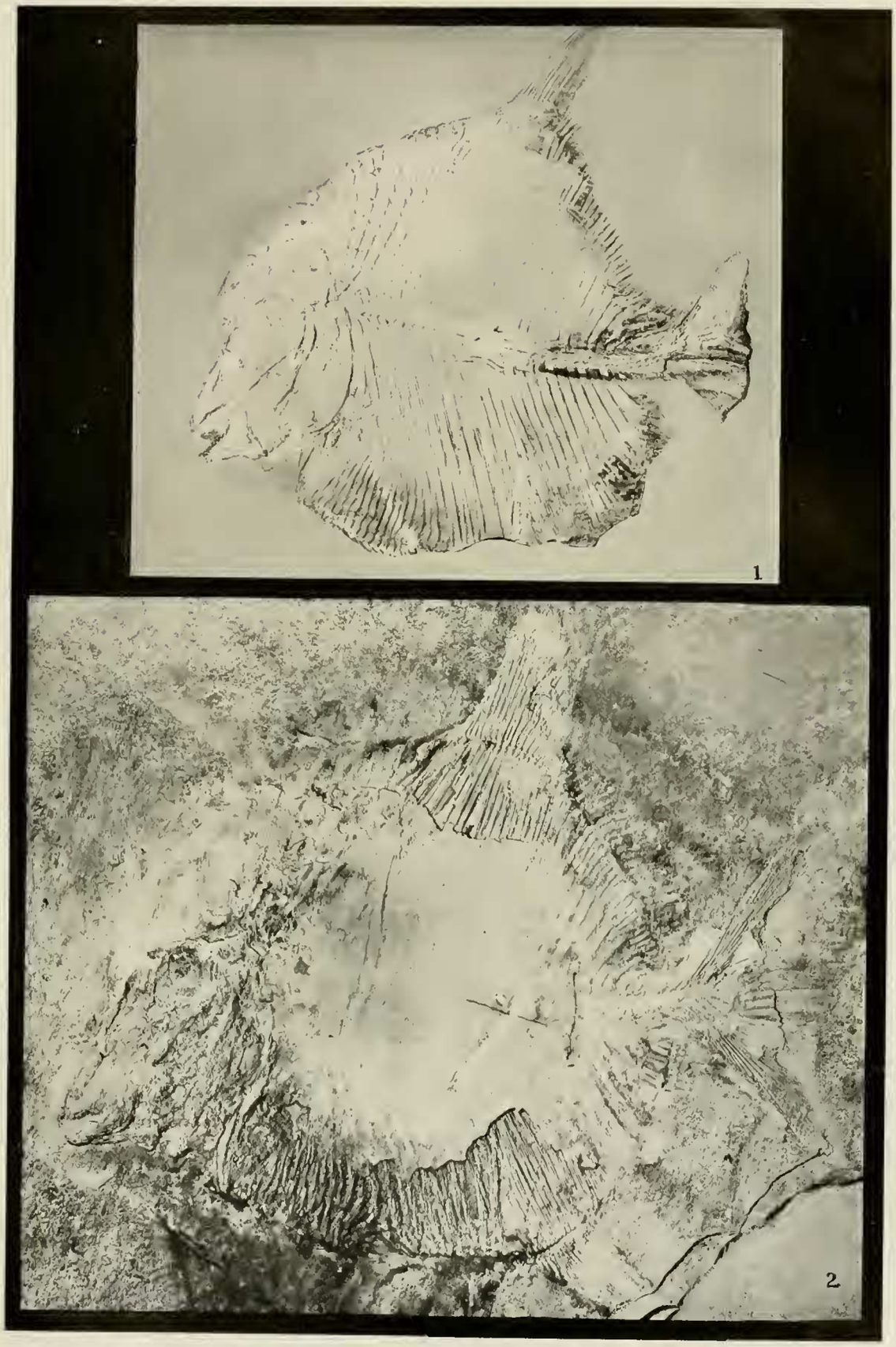

FIG. 1. *Microdon Wagneri* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, NO. 4090. $\times \frac{3}{4}$.
FIG. 2. *Microdon Wagneri* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, NO. 4320. $\times \frac{1}{2}$.

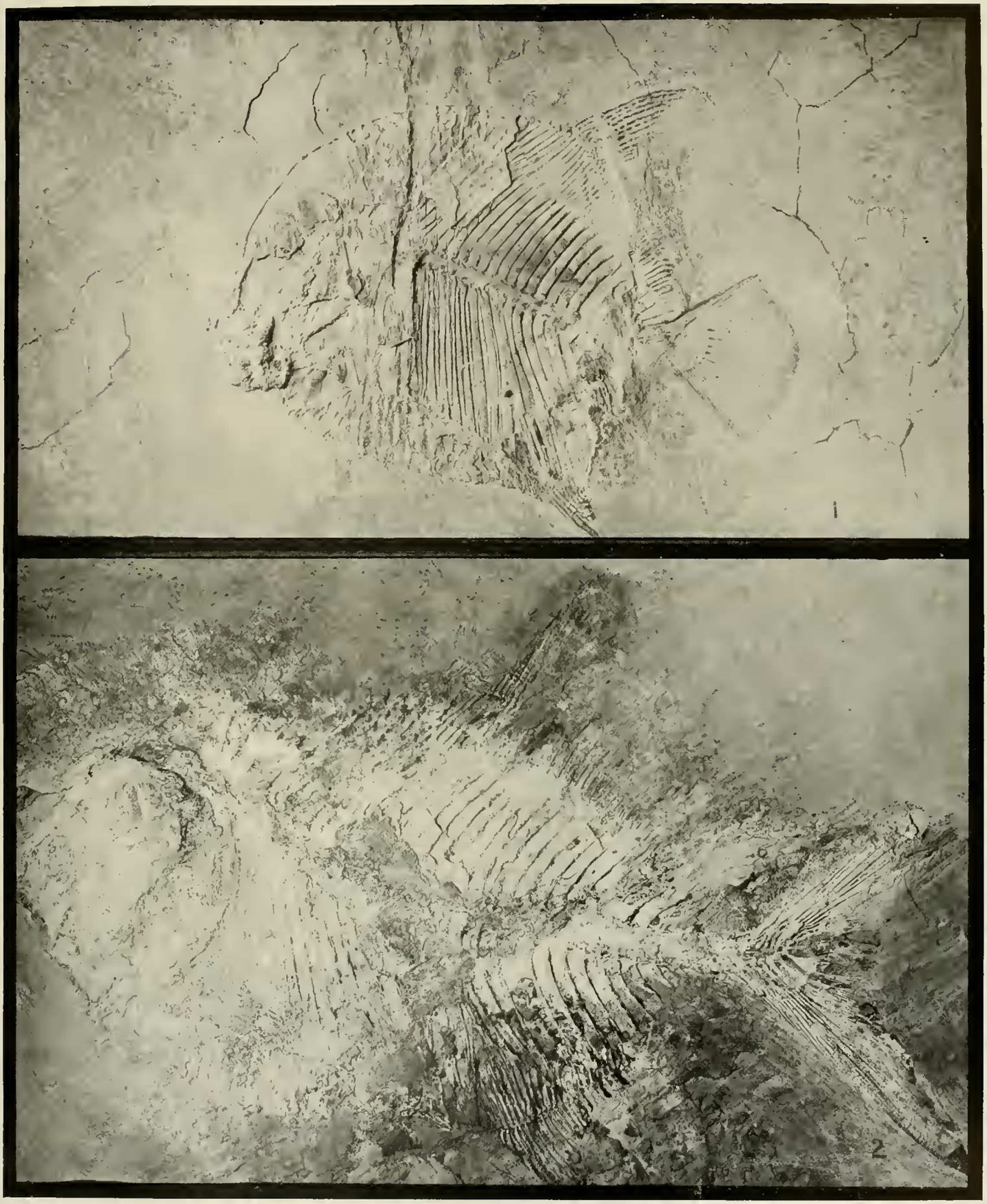

FIG. 1. *Microdon egertoni* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, No. 5107. $\times \frac{4}{5}$.
FIG. 2. *Microdon sauvanausi* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, No. 4666. $\times \frac{53}{100}$.

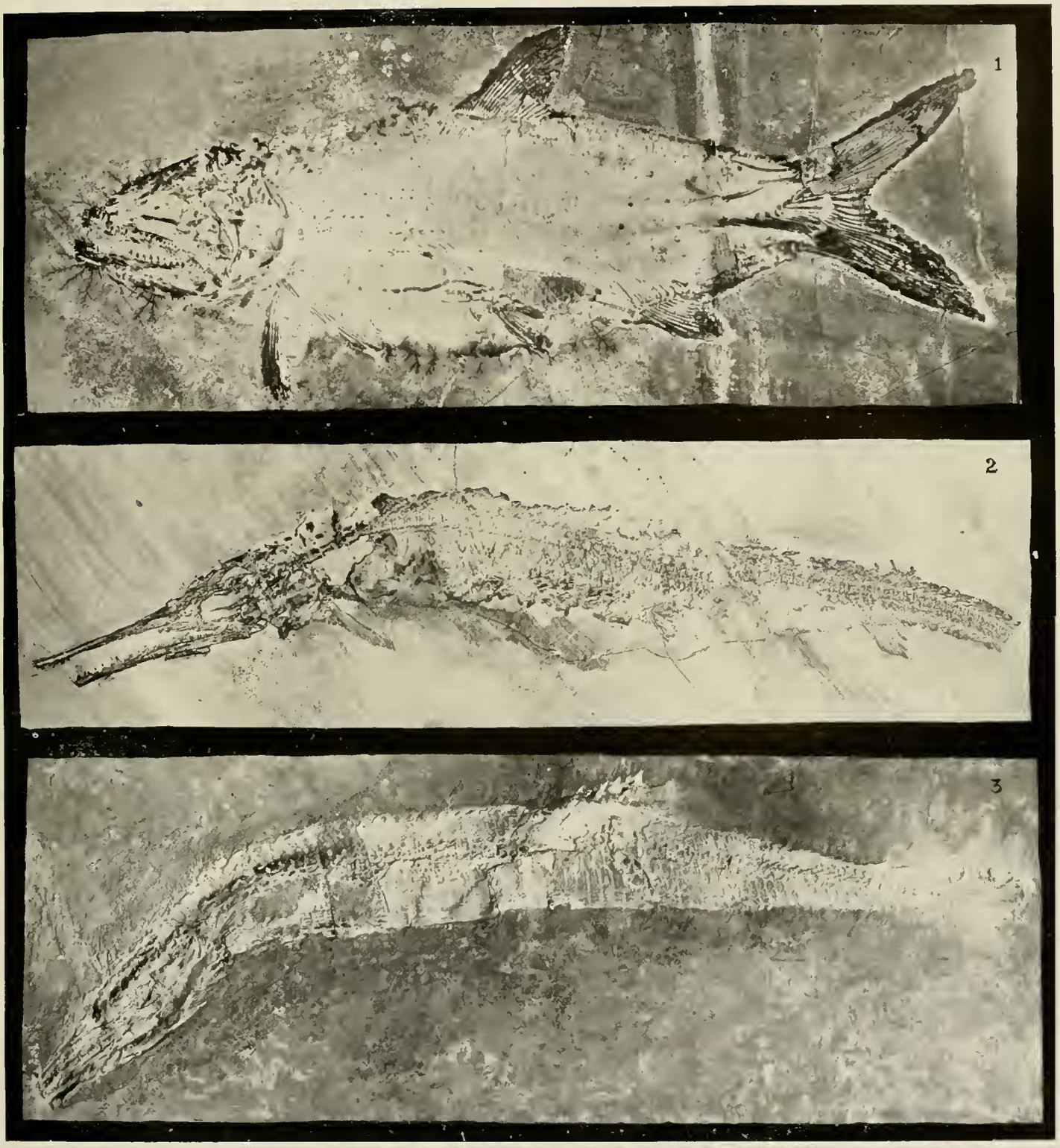

FIG. 1. *Caturus furcatus* (AGASSIZ). C. M. CAT. FOSS. FISHES, No. 4301. $\times \frac{4}{5}$.
FIG. 2. *Belenostomus muensteri* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4343. $\times \frac{3}{4}$.
FIG. 3. *Belenostomus muensteri* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 5112. $\times \frac{5}{6}$.

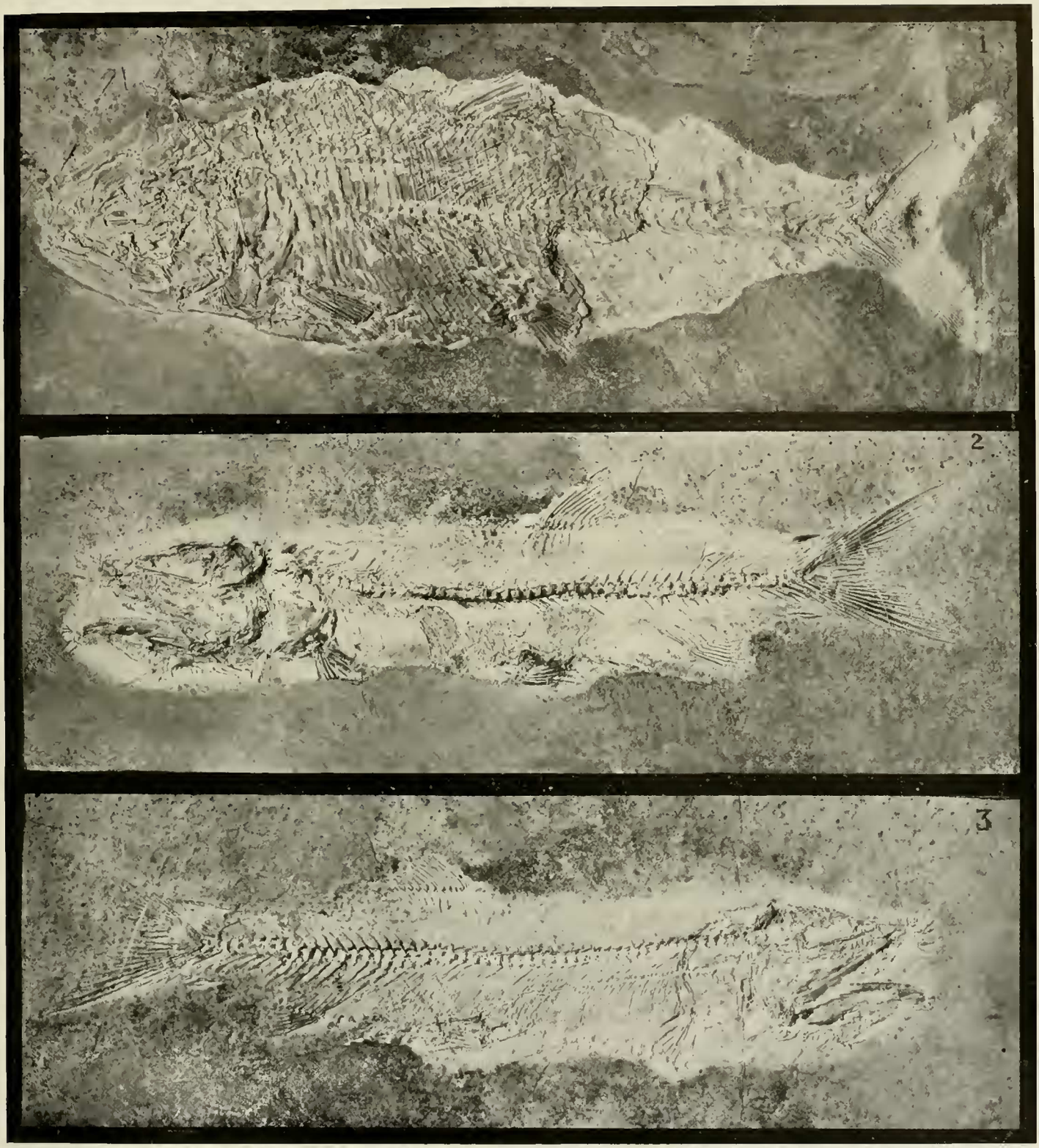

FIG. 1. *Pholidophorus similis* A. S. WOODWARD. C. M. CAT. FOSS. FISHES, No. 4081. $\times \frac{7}{8}$.
FIG. 2. *Œonoscopus elongatus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4079. $\times \frac{7}{8}$.
FIG. 3. *Œonoscopus elongatus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4079a. $\times \frac{7}{8}$.